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THE TWELVE PRINCIPLES OF EFFICIENCY

AND THE ORGANIZATION WHICH MAKES THEIR APPLICATION POSSIBLE.

*By Harrington Emerson.**

The invisible makes the nation. The nation is not made great, it is not made rich, it is not made at all, by mines and forests and prairies and water powers. Great men make a great nation great, and the qualities that make men great are invisible.—*Lyman Abbott.*

THE owners of a large industrial plant with many orders ahead desired to increase the output from thirteen units a month, the highest average up to that time, to twenty-three units a month, and to do this in ten months.

The manager of the plant, a man of unusual ability but of the old school, had been in charge for some time, but knew only one way to deliver the increase, namely, to add to the equipment and employ more men. He therefore countered the demand of the owners for twenty-three units by asking for $500,000 worth of additional equipment. Even if this capital investment had been possible, it was no solution of the difficulty, as it would have taken at least a year, probably longer, to secure the new equipment.

When matters were in this state—demand for increased output by owners, demand for increased equipment by manager—an investigation of the plant was made by two competent efficiency engineers of wide experience, who submitted a long report of which the concluding paragraphs were:—

* In order to obtain suitable space, our salutation and welcome to this new and great series by Mr. Emerson is placed in our Editorial Comment, immediately following the leading articles in this issue.

Your plant consists of a large
Machine Shop,
Boiler Shop,
Erecting Shop,
Blacksmith Shop,
Foundry.

Having examined into the conditions of each of the shops and having consulted with the manager, the superintendent, the various foremen, some of the contractors, and a number of men, we are able to state definitely that with some slight physical betterments, and provided the present manager, or a man of similar disposition be in authority, the output of your shops can be increased 60 per cent, without adding to the present forces, without adding to the equipment, and without increasing the payroll more than 10 per cent, and that these results can be gradually attained within a period of six months.

To accomplish these results certain principles of organization were advocated. The organization and principles were adopted and applied by the managers, and the results are shown by an extract from a letter, written by the local official ten months later.

NEW YORK, May 1, 1908.

It will interest you to know that our output for the month of April showed an increase of 69.2 per cent over the monthly average of the last fiscal year.

The average working hours are 9 per day instead of 10 as formerly. The payroll reduction is 15 per cent, amounting to $8,000 to $10,000 a month less than last year.

The same efficiency engineers were subsequently called to another plant, to investigate and to advise. In this case also their principles were accepted, their recommendations carried into effect through modified organization with the following results:

Date.	Average No. of Men.	Average Tons per man.	Total Tonnage.	Pay Roll.	Pay Roll Cost per Ton.	Increased Earnings of Men.
Sept., '08..	527	4.69	2,473	$29,380	$11.88	0 per cent
July, '09..	263	9.04	2,377	15,248	6.41	2 per cent
Aug., '09..	298	10.51	3,133	17,280	5.51	10 per cent
Sept., '09..	312	10.92	3,408	17,394	5.14	17.3 per cent

It is not to be supposed that two men could come from the far west, go into eastern industrial plants, and through their own familiarity with the conditions know better how to direct them than the experienced local managers in charge. The men who came out of the west were not as well equipped with knowledge of operation or devices, were not as well acquainted with local methods and men, as the

local managers, but they were far better equipped with knowledge of a new type of organization through which alone efficiency can be secured, and they had not only this knowledge but also extended and successful experience in applying it. The difference in achievement between the modern man and the men who lived thousands of years ago is not an internal difference in quality of brain, but the tremendous external difference in conditions and equipment. The boy with the far-reaching sling knocks out the heavily armored spear-wielding giant.

It is exceedingly difficult to advocate certain principles without individuals, tribes, and nations, unable to free themselves from the personal point of view, immediately jumping to the conclusion that an attack is being made on their competency, their skill. Greek athletes could have made good records if they had had bicycles, motor cars, and aeroplanes, if they had had repeating pistols and rifles; but the arrow, however skilled the archer, does not carry as far or as straight as the rifle bullet. The principle underlying the rifle is very old—that of the blow tube—a very different principle from that of the bow and string; but the man who equips the savage with a rifle makes him more powerful than all the armored knights of chivalry, and the man who equips the modern industrial manager with a new industrial application of an old principle of organization and accomplishment, gives the mediocre manager a greater possibility of attaining high efficiency than was ever possessed even by the greatest industrial geniuses working along the old lines.*

The men from the west knew the new theories because they had applied them on a tremendous scale; they knew how to design and operate a new kind of shop control, as different from the old as the rifle is from the bow—as different as bicycle riding is from walking, flying from motoring, Arabic notation from Roman numerals. These principles in their application to shop control may not appear particularly lofty, inspiring, or even interesting to anyone except those whose pocketbooks are to be immediately benefited—namely, the plant owners and managers, the plant workers, and the clients of the plant; but they will evoke deeper interest when it is perceived that they are fundamental and of universal application; that in all ages lasting efficiency depended on them, and without them is always impossible; that the same principles have been applied elsewhere on a stupendous and noble scale, and that it is not men or materials,

* "Two kinds of success, that of the rare genius, the other, that of the ordinary man who does ordinary things a little better than his fellows." Roosevelt's university address in Norway.

money, machines, and methods that count, but far more potently theories and principles.

We hope to arouse interest in these theories and principles and enthusiasm for them, not by sordid reference to the shop gains (although this is after all a valid ultimate test of their value) but by showing their power in recent history; and then, we can begin at the beginning and trace them up from a pre-human past into their noble work of empire building, into their not less valuable future work of industrial upbuilding.

Two of the most remarkable historical events of the last forty years are the transference of the leadership in Europe from a French Emperor to a German Emperor, the transference of leadership in the oriental North Pacific from a Chinese Emperor and a Russian Emperor to a Japanese Emperor.

As each of these startling advances was due to the same theories, organization, and principles, and as these theories, organization, and principles are equally applicable to industrial advancement, it is worth while to understand what was done and how it was done, especially as the solution of similar problems in all civilized activities is plainly the task of the Twentieth Century.

As to North and South America the Sixteenth Century was the era of discovery; the Seventeenth Century, the era of appropriation and settlement; the Eighteenth Century and the first quarter of the Nineteenth Century, the era both of making permanent what had been gained and of developing natural resources; so the Twentieth Century dawns with the as yet unaccomplished task of conservation, of eliminating wastes—wanton and wicked wastes of all kinds, wastes that make our civic governments a by-word, our destruction of natural resources a world scandal, our complacent industrial inefficiency a peculiarly national disgrace, since, of all nations, we Americans ought to know better.

It is this national inefficiency, this national wastefulness, this national squandering of current and future material, human and machine resources, that can be remedied, if we but believe and practice the plainest teachings of recent history, which are an appropriate introduction to a statement of efficiency principles and organization.

After 1850, Louis Napoleon was for twenty years the dominant figure in European politics. The British cultivated his friendship, the Italians looked to him for liberation, the Turk begged his protection, Russia was humbled by him, and Austria sought his alliance. But in the little kingdom of Prussia, about the size of Colorado, there

were two men—Bismarck, the Statesman, and von Moltke the organizer, the General—who entered into a partnership to make their king the Overlord of Europe. King William had succeeded to the throne of Prussia in 1861. He was 64 years old, imbued with all the mouldy traditions of the past, but he trusted implicitly his two advisers.

Prussia was a small, poor, second-rate power comprising about one-fourth of Germany and Austria in area and population, and it was not conceded by the balance of Germany that Prussia had any right to lead. Nobody outside of Germany cared a fig for Prussia.

There was only one way to carry out the dream of the King's two advisers. There must be

(1) A definite plan, with (2) Power at each crisis
to make the plan effective.

The two instruments were to be diplomacy and the army; diplomacy—to put each opponent in turn in a tight place, and then—the army, wherewith to crush him. We are not concerned with the diplomacy. It took great skill to provoke each quarrel at exactly the right moment, and war was brought on each time in the pleasant summer season. Von Moltke's task was however far more difficult. He could not count on having as many men, as much money, as abundant equipment, or as much material, as his opponents. It was evident to him that invisible theories and principles, which his self-sufficient opponents did not recognize until too late, would have to make up for meagre material resources, human lethargy, and awkward equipment.

The struggle, before it began, even in its first planning, was to be one of efficiency against inefficiency; of efficiency, applying to the army all the twelve principles, through a new conception of military organization.

Seconded by Bismarck, von Moltke advised the king to create the army, even though the people objected; and their very opposition served von Moltke, since it enabled him to carry into effect his theories and principles without meddlesome and incompetent interference.

To begin the great game, a quarrel with poor little Denmark was started. Austria, Prussia's great rival in Germany, was invited to become an ally in a war against Denmark in 1864. Two provinces, Holstein and Schleswig, were wrested from Denmark, Prussia occupying Schleswig, Austria occupying Holstein. This war gave von

Moltke a double chance. He tried out on a small scale his own organization, and studied the weakness of the Austrian organization. In 1866 Bismarck took the next step, quarreled with Austria about Holstein, and precipitated war June 14, 1866, Prussia pitted against nearly all the rest of Germany and Austria. Prussia had at that time about 22,000,000 inhabitants, Austria and the balance of Germany 59,000,000 inhabitants. From a careful study of the American civil war, von Moltke had been learning how not to do it. Bismarck gave some of the smaller German powers twelve hours to come to terms, and then almost as rapidly von Moltke's army ate them up. Two years to a day after the Battle of Gettysburg (which occurred thirty months after the firing on Fort Sumter) the Prussians, with 225,000 men, on July 3, 1866, nineteen days after the declaration of war, defeated the Austrians with 262,000 men. In three weeks more the Austrians begged for an armistice, succeeded by a peace, which transferred the leadership of Germany, held by Austria for 600 years, to Prussia. The whole plan being a business venture in empire building, Austria had to pay to Prussia 40,000,000 thaler (about $30,000,000), the smaller States paying in proportion; and, as the seat of war had from the start been in Austria, the cost of occupation fell in addition on the vanquished. Prussia annexed about 27,000 square miles. We fail to recall that any American industrial corporation ever showed for the same length of time as great gross and net earnings.

Napoleon III, Dictator, awoke too late. Bismarck and von Moltke were already preparing for the next step, the supplanting of the French Emperor by a German Emperor as the war-lord of Europe.

On July 4, 1870, the throne of Spain was offered to a German prince, Leopold. This was probably part of Bismarck's plan to provoke a quarrel. Napoleon stamped his foot once too often and for the last time. The French Emperor declared war July 19, 1870. It is said that von Moltke was asleep when the telegram came, and that when awakened, he said: "You will find the plan of campaign in the third drawer of my desk," and that he then turned over and went to sleep again. This might have been true; for, from that moment, over a million men in Germany stepped, ate, filled every minute of their time, according to pre-arranged plan and schedule. They were called from their homes and private businesses everywhere throughout the kingdoms and States; all the railroads fell in line with all their equipment. There was no confusion, no hysterics, no silly haste—*"Ohne Hast, Ohne Rast."* The citizens called, found their uniforms and arms ready, provisions stored. Because the French plans con-

templated mobilization in nineteen days, von Moltke had planned for eighteen days, knowing that this would place the seat of war in France, not in Germany. The French actually required twenty-one days to mobilize. They were of 86 per cent efficiency, von Moltke neither more nor less than 100 per cent efficient. In eleven days, 450,000 German soldiers were mobilized; on August 2, the first battle was fought; on August 6—only eighteen days after the declaration of war—one of the bloodiest battles occurred. On September 2, forty-five days after the declaration, Napoleon and his army, beaten at Sedan, surrendered and passed as prisoners into Germany.

What is marvelous is not that one great nation vanquished another, not that the victory came so soon, but that von Moltke's plans were so perfect that they were carried out to the day, in spite of the desperate resistance and antagonism of a force as strong as his own, both nations having about 40,000,000 inhabitants.

If it were not so tragically sad, it would be to laugh—to compare this war, planned by the master organizer of the last century, with our own inefficient, procrastinating, ignorantly managed and conducted civil war, dragging its weary and exhausting length through nearly four years, bequeathing a heritage of hate for forty years which it took a foreign war to assuage—bequeathing a stupendous pension burden, nine-tenths of it the money penalty for inefficiency.

In the American civil war each side was inspired by its own lofty ideal—the South by State rights, the North by hatred of human slavery; but neither side knew a single one of the twelve principles of efficiency, and so each side hopelessly floundered.

Von Moltke knew all the twelve principles of efficiency, and for him war was a serious business undertaking, not a frolic nor a fizzle; and because it was a business undertaking, Bismarck charged up every penny of its cost to France, presented the bills, and collected payment, $1,000,000,000, with interest added, besides taking two provinces (Alsace and Loraine) as a fair profit on a business venture.

It is not the pomp and glory of that campaign that appealed to me as I intimately and personally, both in Germany and in France, watched it from start to finish, for there was little of either; but the calm, merciless skill of the play showed me what principles could do when carried into effect by a suitable and competent organization. It was not the German soldiers who won the war; von Moltke would have won equally well had he applied his principles to Italian, Austrian, French, Russian, Japanese or Americans. The German recruits were not enthusiastic, and were below the European average in martial

enthusiasm and spirit. It was not the German drill or tactics that won the war—mere methods, both long ago superseded. It was not the German equipment—mere devices—that won the war. The French *chassepot* was a better gun than the German *Zundnadel,* and the *mitrailleuse* was a better field piece than the Germans possessed. It was not German money that won the war, for France was at once far richer and had far better credit.

It was von Moltke's principles and organization that won; and a generation later the same organization and principles applied by a different race on the other side of the globe produced exactly the same fruit in very similar manner, under other able men.

Because von Moltke supplemented the old type of military organization, because he understood and applied all the twelve principles, the loss of life and limb in his wars was less than in great American industrial and railroad corporations, earning a similar amount, and never before in the world's history was so great a business venture carried through in better manner.

Bismarck died humiliated; von Moltke is no more; but their business teachings live, and the modern German Empire whose every activity puts Great Britain into a senseless panic is next to the greatest example the world has ever seen of the result of modern business principles applied to the development of a modern world power.

The greatest example of the power of rational organization and efficiency principles is not in the German upbuilding, but in the Japanese actual creation in a single generation of a great world power. In 1867 Japan was still feudal. The merchant guild and the thieve's guild were classed together, both beneath contempt. Her peasantry was impoverished; her finest men and women, feudal dependents without initiative. When it was still a treason punishable by death, a few of the Samurai left Japan, not for wealth or amusement or conquest of any kind, but to absorb whatever there might be good in the Western civilization and to bring it back for use in their own beloved country. They conspicuously, consistently, and intelligently put von Moltke's organization into effect in upbuilding their fatherland, and also applied all the twelve principles, which they had probably independently recognized and accepted before they began their quest. In thirty years, Japan with her 40,000,000 people was able to vanquish China with her 400,000,000. In another five years, Russia, the colossus of the North, that had shattered Napoleon I—Russia, the dread of Great Britain, of France, of Germany for 90 years—went down in defeat. American sympathies were with Japan, but scarcely was the

war over before the industrial organization of Japan, as much superior in principle to ours as were her army and navy to those of Russia, began to make us cry out in cowardly fear.

It is not the flesh and blood and brains of the Japanese that make them industrially dangerous; it is not their money, for they are poor, not their equipment, for they have but little, not their material resources, because they are meagre. They are dangerous as industrial competitors because we are dragging along under a type of organization that makes high efficiency impossible—and they are not; because we have not even awakened—and they have—to the fact that principles applied by mediocre men are more powerful for good than the spasmodic floundering of unusually great men.

Since life began on our planet there have always been two types of organization, types that Mr. F. W. Taylor characterizes as functional and as military. The former is an organization to build up, the latter an organization to destroy.

Primitive business was so closely allied to raids, filibustering, buccaneering, slave trading (not to omit our own American Madagascar trade) that it was inevitable that the military type should be extended to business organization the world over—a type now known to be utterly unfitted to modern business conceptions and ideals. It is von Moltke's tremendous gift to the world that, although a soldier hampered by tradition, he applied to the army the other type of organization, the functional type, which ought always to have been used in business.

Because his only chance of winning the great game he and Bismarck planned lay in superior efficiency, he was forced to study all its underlying principles, and he was equally forced to adopt the only type of organization that could apply the principles; yet so invisible was it all that even his keenest enemies saw only the familiar cocked hats, epaulettes, gold lace, and dangling swords—failed to realize that without change of name or interference with rank, even for predatory purposes, the old predatory organization had passed away and been succeeded by the functional, upbuilding, accomplishing organization.

What is all the pride of achievement of the greatest American railroad company compared to the quiet, fore-ordained plans of von Moltke in which no hitch occurred in the supreme test?

What is the greatest American corporation as a working force, compared to the perfect organization of von Moltke, the perfect organization of the small group of Japanese leaders who have made Japan a great world power?

The British, French, German and American managers of the great industrial corporations and railroads are men of great force of character, of stupendous ability, of untiring energy, devoted to the interests entrusted to them; but because they know only empirically what the principles of efficiency are, because even empirically they apply these principles only spasmodically, the plants and railroads whose well-being they are so eager to further, are operated wastefully beyond belief. The losses in American railroad operation alone run to a million dollars a day—losses preventable through the recognition, acceptance, and persistent application of efficiency principles; losses as preventable as yellow-fever deaths at Panama, or as fuel wastes if well designed engines, boilers and furnaces are used.

Efficiency, like hygiene, is a state, an ideal, not a method; but in America we have sought our salvation in methods.

American industrial organization, even when it has good methods, cannot use them, because the organization, inherited from antiquated British models, is so defective in theory as to make an application of the principles as well as of good methods impossible.

In this essay we have attempted to show that conditions of extreme inefficiency in shops as well as in empires can be converted in a very short time into states of high efficiency; that the prime instruments for efficiency in the examples cited were not men, materials, money, machines, and methods, but theories of organization and principles; that inefficiency prevails in all American activities because the type of organization is one that does not lend itself to the application of efficiency principles; that the hope of rapid improvement lies in so amending or supplementing the usual type of organization as to make it possible to apply efficiency principles.

The next essay will outline and contrast the two types of organization, and will show why one is not adapted to secure efficiency, and why the other one is.

COMPENSATION OF WORKMEN AND EFFICIENCY OF OPERATION

By H. L. Gantt.

V. PRICES AND PROFITS. A NEW LIGHT ON THE COST OF LIVING.

With this chapter Mr. Gantt concludes for the present his study of "Work, Wages and Profits." This series of five articles has been, in the words of one ably qualified critic, the "cleanest-cut handling of the subject" yet presented. The topics of the several articles, beginning with that in THE ENGINEERING MAGAZINE for February last, have been: The Compensation of Workmen; Day Work; Piece Work, and Task Work with a Bonus; Fixing Habits of Industry (a most interesting discussion of individual and shop records, illustrated by colored charts, in our May issue); and now finally, Profits.

The entire series, revised and much enlarged by the inclusion of new matter, will be republished by THE ENGINEERING MAGAZINE in book form. The volume, under the title "Work, Wages and Profits," is now on the press.—THE EDITORS.

INASMUCH as the chief object in manufacturing is to make profits, it seems desirable to consider more specifically the subject of profits and the effect exerted upon them by our methods.

As business increases in volume, profits will normally increase correspondingly; but there are only two ways of substantially increasing the profits on the article manufactured—one by increasing the selling price, the other by reducing the cost of production.

Inasmuch as increase of selling price yields more prompt returns, and returns that can be measured with great accuracy, much of the talent of our manufacturers has been engaged in this branch of the business. The successful salesman, or the operator who has succeeded in persuading his competitors to join with him in upholding or advancing prices, on account of the increased profits resulting from his efforts has been considered a very important man and compensated accordingly. The recognition of ability, and the compensation for success in this field, have been so great that capable workers from all directions have swarmed into it, and the industry of making prices has prospered amazingly, to the comparative neglect, often, of the production end of business.

With increase of prices comes higher cost of living; with higher cost of living comes demand for higher wages; with higher wages comes higher cost of production. Then, to maintain the same profit under the new conditions, we must again increase our selling price, and the cycle repeats itself. This process has been going on for years, and as the producers have been gradually attracted from the

field of making products to the more lucrative one of making prices, we have now, in many fields, a surplus of prices and a shortage of products. This condition is today acute in the farming industry, and affects directly the cost of living.

Let us now consider the other alternative—that of reducing cost—and ask why more attention has not been paid to it, and what we may expect to get if we cultivate this field as assiduously as we have done the first.

The first cause of the small interest hitherto shown in the effort to improve production is that there is still a lingering feeling among many prominent people that the shop worker is not entitled to the same degree of consideration as the office worker; and this work cannot be done in the office. It must be done amid dirt, dust and the noise of machinery. It must be done by not only studying individually the machines that do the work; but by also studying individually the men that operate them. This is work that requires ability quite as great as, if not more greater than, that needed for the making of prices; it also requires long hours and overalls; and the compensation for success in this line does not compare with that accorded the man who adds to the bank account by getting a higher selling price.

On account of these conditions the effecting of economies in factories is usually left to the partially educated mechanic or clerk, who, whatever his success, seldom gets an adequate reward. When the compensation for success in this latter branch is made commensurate with that in the former, and then only, will it attract and hold educated men, to whom we must look for the success in any work requiring study or investigation. Study of men and processes is difficult, and we have done but little in this country to encourage it; but the time has come when we must turn our attention to it at once, for the combination of the high cost of living, and the inefficiency of production in almost all lines, is rapidly producing a condition of which no one can foresee the result.

The horizontal increase of wages being granted by so many corporations throughout the United States is not a cure, but an expedient only to enable the workmen to supply themselves for the present with a larger proportion of the necessities of life. Such a scheme provides temporary relief only, for a general increase of wages increases costs again; and, if such a policy is followed, it will not be long before a new increase of wages will be needed to meet the continually rising cost of living.

The one cure, the only one, for the condition that confronts us, is to increase the efficiency of the producer. This is not an easy prob-

lem; and there is no royal road to the desired end, for, as was said before, it means long hours and overalls, and the ability to study men and machines in the surroundings of dirt, dust and noise.

As was said before, also, this work does not attract many educated or capable men, because the compensation for success is so meager; but the time is rapidly approaching when the men that can do this work well, will be in demand at almost any price. This is peculiarly the work of the mechanical engineer, and manufacturers who realize this fact and take advantage of it will be surprised at the benefits.

It is an economic law that large profits can be permanently secured only by efficient operation; and any man, or body of men, that exacts a compensation out of proportion to the service rendered will ultimately come to grief. The supreme importance of efficiency as an economic factor was first realized by the Germans, and it is this fact that has enabled them to advance their industrial condition, which twenty years ago was a jest, to the first place in Europe, if not in the world. We naturally want to know in detail the methods they have used; and the reply is that they have recognized the value of the scientifically trained engineer as an economic factor.

In the United States, superb natural resources have enabled us to make phenomenal progress without much regard to the teachings of science, and in many cases in spite of our neglect of them. The progress of Germany warns us that we have now reached the point where we must recognize that the proper application of science to industry is of vital importance to the future prosperity of the country.

Many of our most prominent men, and men of most influence in the country, received their college training before the possibility of such a condition was even hinted at; and hence they fail to realize its seriousness. Our universities and schools of higher learning are still dominated by those whose training was largely literary or classical, and they utterly fail to realize the difference between a *classical* and an *industrial* age. This difference is not sentimental, but real; for that nation which is industrially most efficient will soon become the richest and most powerful.

If we wish to hold our place in the procession we must at once accord the scientist the place he is entitled to, and we must recognize his work, and that of the engineer, by such financial compensation as will attract our best men.

A few years ago efficiency in the United States was a local question; today it is a national question, and co-operation for its promotion will not only be of great permanent benefit to those co-operating, but will have a great educational effect on the nation at large.

Co-operation to uphold or to raise prices is seen on all sides; but it is difficult to find a single case where there has been any serious attempt at co-operation to study economies, and to inaugurate them effectively. Systematic work in this line would do more to increase prosperity, and to reduce prices, than all other influences combined; and the result might be accomplished without decreasing profits.

Moreover, if it should become the fashion to co-operate for the effecting of economies, instead of for raising prices, we should not need so much new legislation to restrain the activities of some of our most enterprising citizens.

Although the application of the scientific method to the larger problems of engineering and manufacture has been most rapid within recent years, and the great advances made testify to its success, its application to the innumerable small details of work has been largely neglected. These details have been regarded as being in the domain of trades rather than of engineering, and have been left to the mechanic. Inasmuch as mechanics, as a class, get but little benefit from the development of a better method, or a labor-saving process, they are as a rule little interested in such improvements. It is not surprising, therefore, that labor unions should offer a distinct opposition to such improvements, and that workers trained in the atmosphere of the union should consider it their duty to perpetuate this hostility. To avert this hostility we must begin by giving workmen a different training.

Before the advent of the modern factory system, each master workman owned his little shop, which he ran with the assistance of two or three journeymen; and in which he personally superintended the training of his apprentices. In training apprentices, his first object was to provide himself with capable journeymen; but he also realized that the best way to increase his reputation was to send forth men that should be a credit to him. He was therefore doubly particular that no one should leave his shop who was not able to do his work well.

With the coming of the factory system, the owner became too busy to give much personal attention to the apprentices, and as the factories grew larger, he was often unable to take from the business end enough time to make himself even, a master workman in all branches of his work. With the increasing size of the factory the superintendent also became too busy to give much personal attention to the apprentices, and they were thus left to receive their training from the foreman and their fellow-workmen, who, as a rule, have no

financial interest in training additional men, who may, in time, become their competitors. This is undoubtedly the most important reason why the old apprentice system has gradually become less effective, until today it is almost obsolete. It is also a good reason why an attempt to revive it in its old form is foredoomed to failure.

The principles on which the old apprenticeship system was founded are sound—namely, that the success of the pupil should add to the reputation and financial betterment of the teacher and pupil both. It would seem, then, that if our modern methods have a similar foundation, they also will be successful. Moreover, if the training is based on the results of scientific investigation, and the methods employed are those which embody our best knowledge on the subject of teaching, we should be able, not only to provide ourselves with an abundance of skilled workmen who are capable of doing well the tasks set them, but to develop many who are able to advance the mechanic arts in a manner superior to that which gave the New England master workman of a generation ago such a wide reputation.

There is really no sharp line between mechanical engineering and trades. Wherever there is a problem to be solved, no matter how small or common-place, there is work for the educated man; and his solution by the scientific method is, as a rule, so much better than that of the mechanic without scientific knowledge, that workmen trained in the light of such a solution are far more efficient than those trained by mechanics in their methods. The increased efficiency of such men entitles them to increased compensation; and, by awarding that compensation in a proper manner, I have never failed to secure the hearty co-operation of the good men. *A system of management based on these methods is just as much a part of our assets as plant, or equipment.*

We are all familiar with plants that were failures under one manager and successes under another, or *vice versa;* but so far no satisfactory method is generally known by which a system of management can be put into such a shape as to be self-perpetuating. This is exactly what the methods described in preceding articles do accomplish, at least to a large extent. The importance of this fact is second only to that of one other, namely, that they do actually get the highest possible efficiency.

The reason our methods are permanent is that it is to the financial interest of both workman and foreman to maintain them. All other systems are maintained in their efficiency by the higher officers, and hence are liable to deteriorate when such officers become old, or are

replaced. The system I have described not only makes for the highest efficiency, but is practically self-perpetuating, for the training the men receive fits each to fill a higher position.

In considering in detail the elements that affect costs of manufacture and through them, profits, most people place them in three classes:—

Wages,
Materials,
Overhead expense.

In the third class they include all the various items of expense that cannot be charged up directly to manufacturing, such as rent, taxes, insurance, salaries, selling expenses, depreciation, power, light, heat, etc. These items taken together, often amount to more than the wages paid for doing the work. This class of expense is very important, for it goes on with but little change day after day whether we do much work or little, and must be added to the cost of the output, month by month. If the output is small, this burden of expense per unit of output is large; on the other hand, if the output is large this expense per unit is correspondingly less.

Andrew Carnegie was one of the first men to appreciate to what extent this was a fact, and by making good use of it, he laid the foundation for the practical control of the steel industry.

If the output of a plant is doubled, the overhead expense per unit of product is very nearly cut in half. If at the same time we reduce the wage cost 40 per cent and double production, as we have shown can so often be done, the profits mount at a very rapid rate.

In order to illustrate these points, let us assume a hypothetical case in which we are making a profit of 10 per cent on the cost of our products, our expenses for one week being divided as assumed in the following table, which is closely in accord with probabilities:—

Material	$3,000
Wages	1,000
Expense Burden	1,000
	$5,000
Selling Price	5,500
Profit	$ 500—10 per cent of cost

Suppose now we wish to double our product. The usual method is to double the size of the plant without increasing the efficiency of operation. In this case all expenses will be doubled, except the ex-

pense burden, which will be very nearly doubled, and our case may be approximately represented by the following figures:—

Material	$6,000
Wages	2,000
Expense Burden	1,800
	$9,800
Selling Price	11,000
Profit	$1,200—12 per cent of cost

Suppose, on the other hand, we double our product by increasing the efficiency of operation, as we have shown can often be done, without increasing the size of the plant or the number of workmen. The following figures will be fairly representative:—

Material	$6,000
Wages	1,400
Expense Burden	1,200
	$8,600
Selling Price	11,000
Profit	$2,400—28 per cent of cost

The profit is nearly five times as great as in the first case, and twice as great as in the second. In the second case we have twice as much money invested in the plant as in the first and third cases. *But in the third case, where we have increased efficiency and reduced costs, the profit on invested capital is nearly five times that in either of the first two cases.*

While these figures are hypothetical, and are not applicable to all industries, they are conservative, as they represent a decrease in total cost of only 14 per cent, as may be seen by comparing $5,000, the cost in the first case, with $8,600, the cost of double the products in the last case. To get a similar increase of profit by increasing the selling price without enlarging the plant or increasing efficiency, we should have been obliged to sell goods that cost us $5,000 for $7,400, or at a profit of nearly 50 per cent. Such an increase in selling price would simply be an invitation to other competitors to come into the field. If such a competitor should operate as efficiently as we have assumed to be possible in our third case, and competition should force the price down, he could sell his goods for less than our original cost and still make a profit of 15 per cent.

If manufacturers in general realized how much an increase in efficient operation really meant to them, they would be very slow to increase the size of a plant until they had become pretty well convinced that they had gotten it up to its maximum efficiency.

What has been said of the manufacturer is true of that greatest of producers, the farmer, as well; but we must not expect him to understand what the more favored manufacturer so often fails to appreciate, namely, that efficient operation of a small plant, or farm, is more profitable than the slack operation of a large one.

If the same intelligence and industry had been applied generally to the art of production as has been exercised in selling products, I can hardly help feeling that we should be suffering less acutely today from high prices. In the long run prices are governed by supply and demand. When it comes to be generally realized that efficient production and a large, cheap, product form a more stable basis for profits than a small, expensive one, because they form a more stable basis for prosperity, we may hope that some of the talent that has been exploiting the overworked field of making prices will return to the comparatively fallow field of making products.

I do not wish to be understood as intimating that nothing has been done in this field. Much has been done, especially in the steel industry; but it is a mere drop in the bucket, when compared with what still remains to be done in almost all productive industries. The steel industry was one of the first to utilize educated engineers, and to study the methods of efficient operation. The fact that steel products brought high prices has never stood in the way of reducing cost; and today, thanks to this policy, American steel makers can compete with any in the world.

If the much boasted superiority of the American people is really a fact, and the phenomenal progress of the past is really due to the ability of the people of the United States and not mainly to splendid natural resources, we should rise to the occasion, and become the example for others to point to. This cannot be done by making prices; and a tariff that is so high as to enable profits to be made regardless of cost is not a protection, but a decided detriment to the country. A tariff that encourages efficiency is more to be desired than that which will enable its beneficiaries to accumulate wealth, *for any prosperity not based on efficiency is on an unstable foundation.*

In order to bring the efficiency of operation up to the point we have shown to be possible, we must first have absolute control of the materials we use and the tools we work with. In other words, we must see that the proper materials are always ready, and that proper tools for doing the work are available. This is a function of the management, and not of the workmen, and necessitates the keeping of an exact record of the materials used. Inasmuch as material represents money, any attempt to keep an exact record of it, and of

where and how waste occurs, results at once in a saving far in excess of the cost of keeping the records.

When therefore we begin to install a system of management on the lines indicated, nearly every step produces a saving; but as many concerns have no records that show losses of material and leaks, it is usually difficult to show what has been saved by stopping such losses. Again, when we begin to put machinery in condition to enable us to run it at its proper efficiency, and to enable each man to do a proper day's work, the expense incurred to accomplish this end is usually charged against the "new system," whereas *it should be charged against the system that put the machinery out of condition.*

Inasmuch as in any change in management the mechanism of the old system must not be disturbed until that of the new system is working smoothly, there is always some time when we must practically run two systems. From these considerations it is evident, that no matter how much we may be able to increase the profits in the long run, we must not expect results to show in the form of profits at once.

The total cost of making the change from the old system to the new is not greatly different, whether it be done quickly or slowly. If it is done quickly, the benefits are gotten that much sooner; but the expense is concentrated in a short time, and unless this fact is realized from the start, it is apt to cause a certain amount of hesitation at the very time when the work should be pushed fastest. If the plant is a large one, or one doing a large variety of work, the advantages of controlling the material, planning the work, and increasing the efficiency of the individual, are so great that a little done in this direction soon makes itself felt, for the plant begins to run more smoothly, wastes diminish, and profits begin to increase, and we are on the road to our ideal, *a self-perpetuating system of management based on the efficient utilization of scientific knowledge.*

Such a system seems Utopian. Perhaps it is, but we have seen the possibilities of it so clearly, and have in actual operation approximations to it so close, that we are prepared to see its realization in the near future. Under such a system in its best development we have co-operation like that in a foot-ball team, or an orchestra, where each man has assigned to him the part he can do best, and where he does it with pride and joy to the best of his ability. The organization of such a system must be perfected by men familiar with industries and trained in the methods of scientific investigation. The graduates of our engineering schools are the men on whose shoulders this problem naturally falls, and if they are capable of handling it, they will gain for the profession of engineering the recognition to which it is already entitled, as the most important factor in modern civilization.

A GENERAL REVIEW OF HYDROELECTRIC-ENGINEERING PRACTICE.

By Frank Koester.

III. TURBINES, WATER WHEELS, AND MECHANICAL EQUIPMENT OF THE POWER PLANT.

Mr. Koester's first article, published in April, was concerned with the impounding of water supplies and the attending engineering construction. His second dealt with head races, pressure pipes and penstocks. He now takes up water-wheels and the mechanical equipment of the power station. In July he will consider the electrical machinery, and in August the transmission and distribution of current. The whole discussion is addressed not to the specialist in hydroelectric engineering, but to those who will value a concise review of the foundational elements in good modern practice—whether as contractors, owners, managers, or financial and commercial associates.—THE EDITORS.

POWER plants are classified according to the available head, into low-head, medium-head, and high-head plants; the first being up to 30 feet, the second from 30 to 200 feet, and the last named (high-head) above 200 feet. This classification, however, is not closely adhered to, as many manufacturers and plant designers are ignorant of the fact that a low-head turbine is less efficient when applied to a high-head, and *vice versa*.

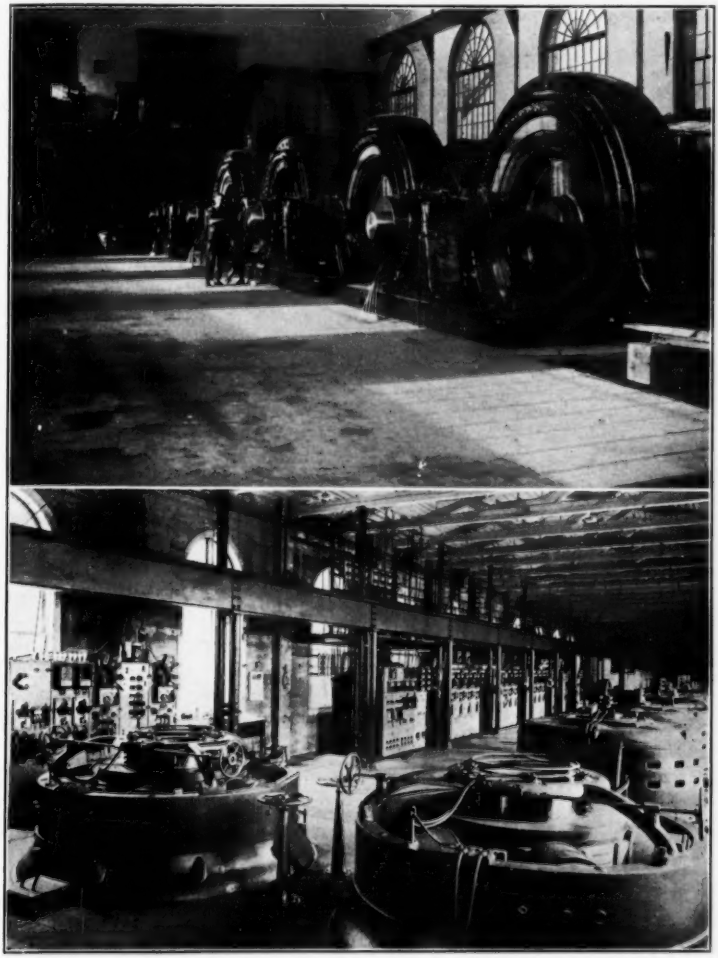
Reputable manufacturers with competent engineering staffs will advise the use of a turbine best suited for the condition at hand. Slight variations of the above classification, of course, may be made when other conditions favor them.

A rigid classification is adopted by European engineers as follows: low-head turbine, up to about 10-feet head, employing open flumes, vertical turbine shafts with bevel gearing; or, when turbines are located above ground water, horizontal shaft with belt or rope drive.

First intermediate-head turbine, from 10 to 30-feet head, in which case open flumes may be used, and vertical, or when advisable, horizontal shafts.

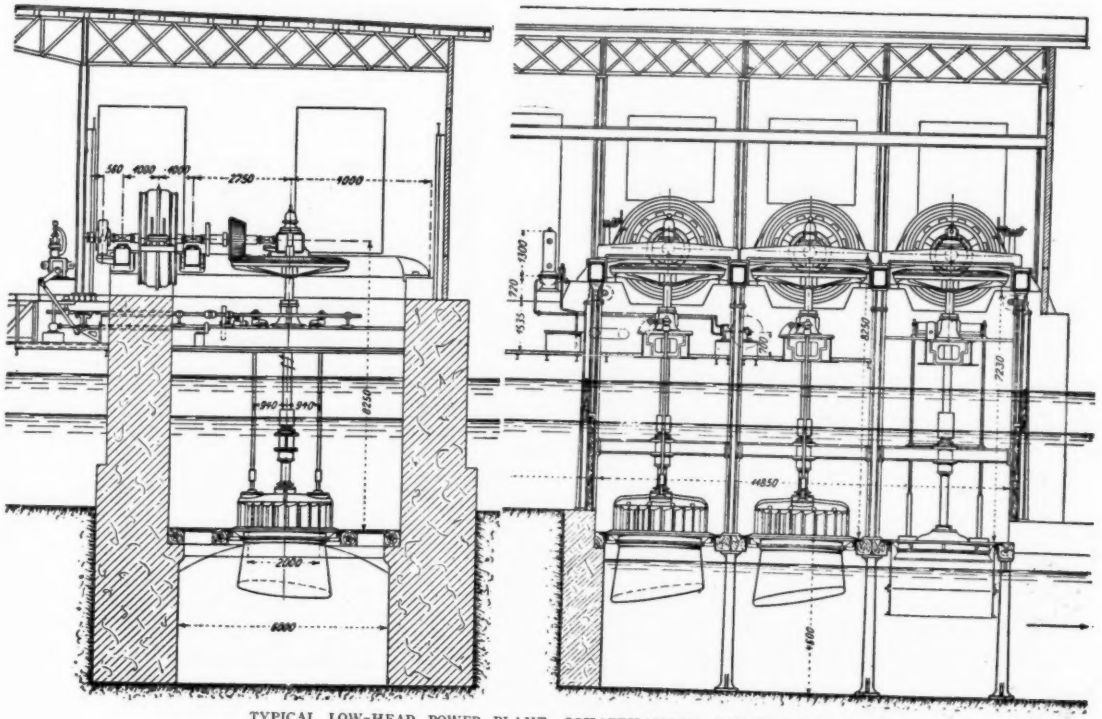
Second intermediate-head turbines, for heads from 30 to 165 feet. Closed penstocks, spiral casing, horizontal shaft. For special conditions vertical shafts may be used.

High-head turbines, above 165-feet head. Closed penstocks, spiral casing; horizontal shafts, so long as reaction wheels are used; otherwise impulse wheels with vertical or horizontal shafts.



AMERICAN HYDROELECTRIC POWER PLANTS. ABOVE, HAUSERLAKE. BELOW, OREGON CITY STATION B, PORTLAND RAILWAY, LIGHT & POWER CO.

Whatever class of turbines is chosen, care should be exercised to locate the turbines so as to secure the highest possible head. Many turbines are dependent upon draft tubes to give additional head. Whatever turbine and arrangement is decided upon, the flow of

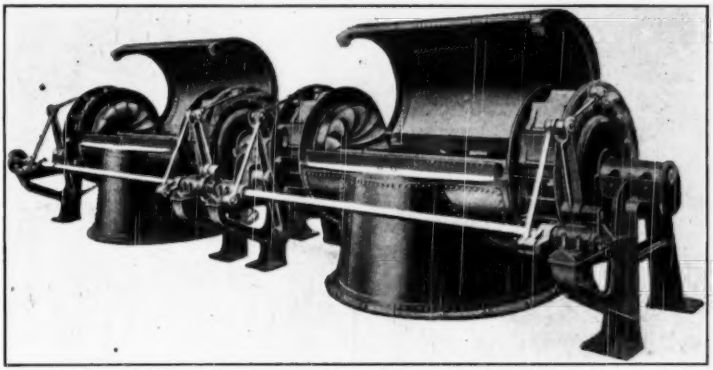


TYPICAL LOW-HEAD POWER PLANT, SCHAFFHAUSEN, SWITZERLAND.

water to and from the turbines should be as free and easy as possible, to avoid friction.

In low and medium-head plants the power house frequently forms a part of the dam, or adjoins the dam on the down-stream side; or, in case of a hollow concrete dam, it is located in the body of the dam; in such case the walls must be made waterproof to prevent seepage into the power house.

Forebays are used in connection with low-head plants, and must be located and arranged so as to deflect all foreign material as much as possible. This may be done in a similar way to that which has been discussed under the chapter on collecting basins such as are used in connection with medium and high-head plants. They must also be provided with screens, spillway, ice-run, and sand trap.



AMERICAN TURBINE AS DESIGNED BY THE DAYTON GLOBE IRON WORKS.

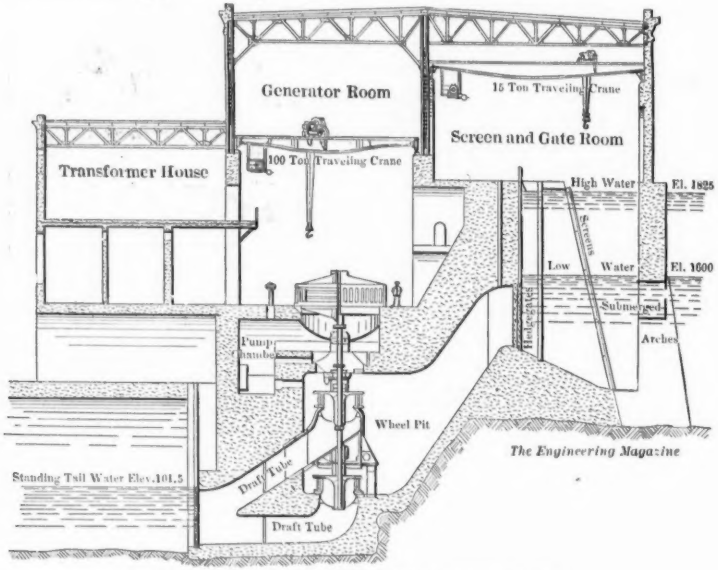
Low-head turbines are usually located in open flumes, and when they are provided with vertical shafts, frequently several turbines are connected by gearing to a horizontal shaft driving a generator. With this arrangement special precaution must be taken to prevent seepage or moisture from entering the generating room.

When the generators are of small size a single turbine may be geared to the generator, as will be seen in the accompanying cross section of the Schaffhausen, Switzerland, power plant, which is a typical low-head installation.

Medium-head plants are usually equipped with Francis turbines with horizontal or vertical shaft. Both arrangements have often two runners mounted upon one shaft.

Page 344 shows the general arrangement of the McCall's Ferry Power Company's plant on the Susquehanna river. The turbines are

of the inward-flow Francis type, mounted in pairs on a single shaft; when operating under a normal head of 53 feet and a speed of 94 revolutions, with a gate opening of 80 per cent, they are capable of developing 13,500 horse power. This plant, when completed, will have a normal capacity of 100,000 horse power, half of which is at present being installed. Considering the general arrangement of this plant, it will be noticed that screens and headgates are arranged in a common building adjoining the generator room and provided with a 15-ton traveling crane to facilitate handling the screens. The generator room, on account of the exceptionally large size generators, is provided with a 100-ton traveling crane. Much space is left between traveling crane and roof truss; this is presumably done for architectural reasons, upon which much stress has been laid, contrary to usual American practice. At the down-stream side of the power house and above the tailrace outlets, is a well arranged switch and transformer house.

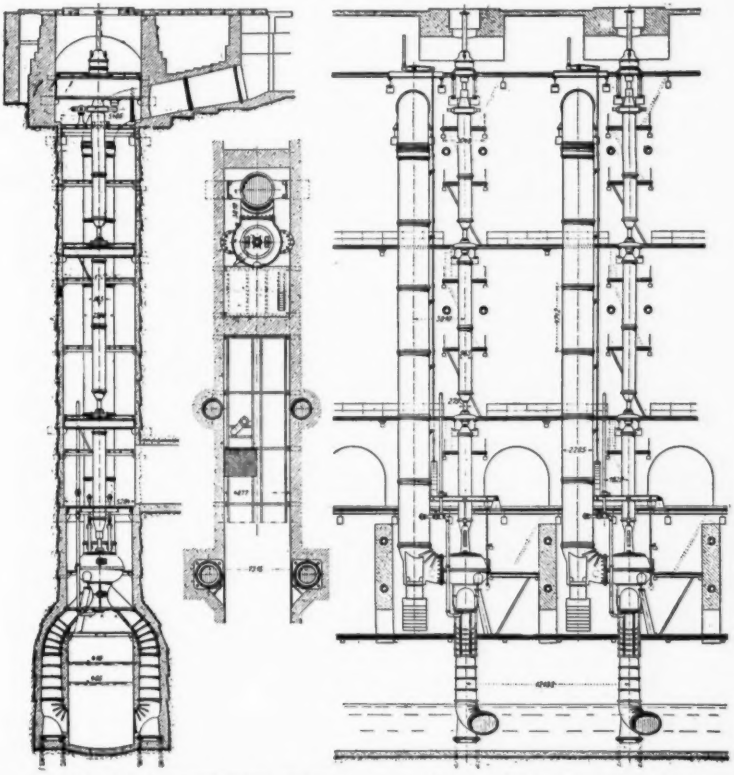


CROSS SECTION, M'CALL'S FERRY POWER HOUSE.

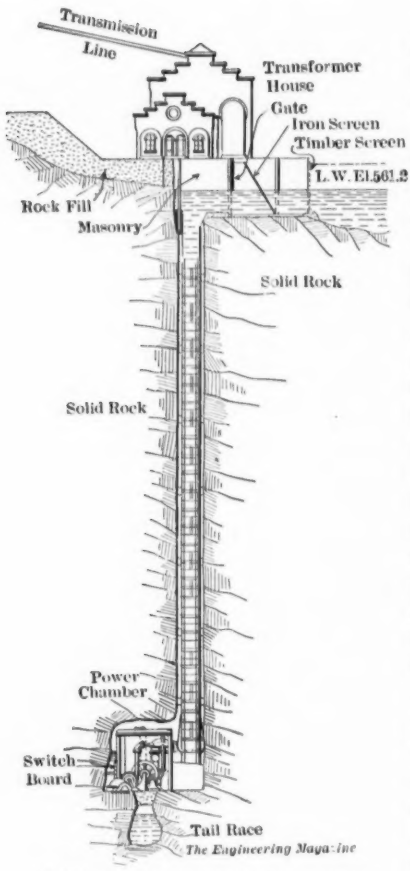
The Niagara Falls plants are also medium-head plants, but are of entirely different design from that of the McCall's Ferry Power Company. Four of these plants have the vertical-shaft turbine located in a pit; the arrangements vary somewhat, especially in the tail-race end. Power House No. 1 of the Niagara Falls Power Company,

equipped in 1895 with 5,000 horse power units, had no draft tubes; in the latter installations, both on the American and Canadian sides, the turbines are equipped with draft tubes of different design. By omitting the draft tubes in the first plant, 700 horse power was lost for each of the ten units.

High-head power plants usually have a simple arrangement of turbines, but, on the other hand, they have a more complicated arrangement of penstock and regulating devices. It is but natural that high-head plants are located away from the center of current distribution, therefore a large electrical equipment is necessary with this type of plant. As the ground is cheap in such localities it would be an unwise policy to crowd the generating room; ample space must be allowed, particularly for the regulating devices.



ARRANGEMENT OF TURBINES, PLANT NO. 2, NIAGARA FALLS POWER COMPANY.



CROSS SECTION, SNOQUALMIE PLANT.

One of the most prominent high-head plants in America is the Kern River Plant No. 1 of the Edison Company, Los Angeles, Cal., though the capacity is not so great as others. The plant contains four 5,000-kilowatt units, each unit consisting of two impulse wheels of 9 feet 8 inches diameter; they are overhung on the shaft of the generator which is located between the two wheels. To harness the water of the river Kern, a dam 203 feet long, 20 feet above the normal river level, was constructed. The water is conducted through nineteen tunnels, aggregating a length of 42,910 feet; then through timber flumes 1,520 feet long; these are followed by reinforced-concrete conduits 503 feet long, which join the collecting basin. From here a penstock of 1,697 feet in length leads to the power house. The penstock, contrary to usual practice, leads through a tunnel, and is surrounded by concrete; it has an internal diameter of 7.5 feet, while near the power house it has a diameter of 5.25 feet.

A unique arrangement of a high-head power plant layout is that of the Snoqualmie Falls and White River Power Company, Washington. A shaft of rectangular section, 27 by 10 feet, was sunk in the river bed about 300 feet above the Snoqualmie Falls. This shaft reached a depth of 270 feet, or the level of the river below the falls, and was connected with a tunnel 24 feet high and 12 feet wide, which is used as tail-race. The underground power station begins at the

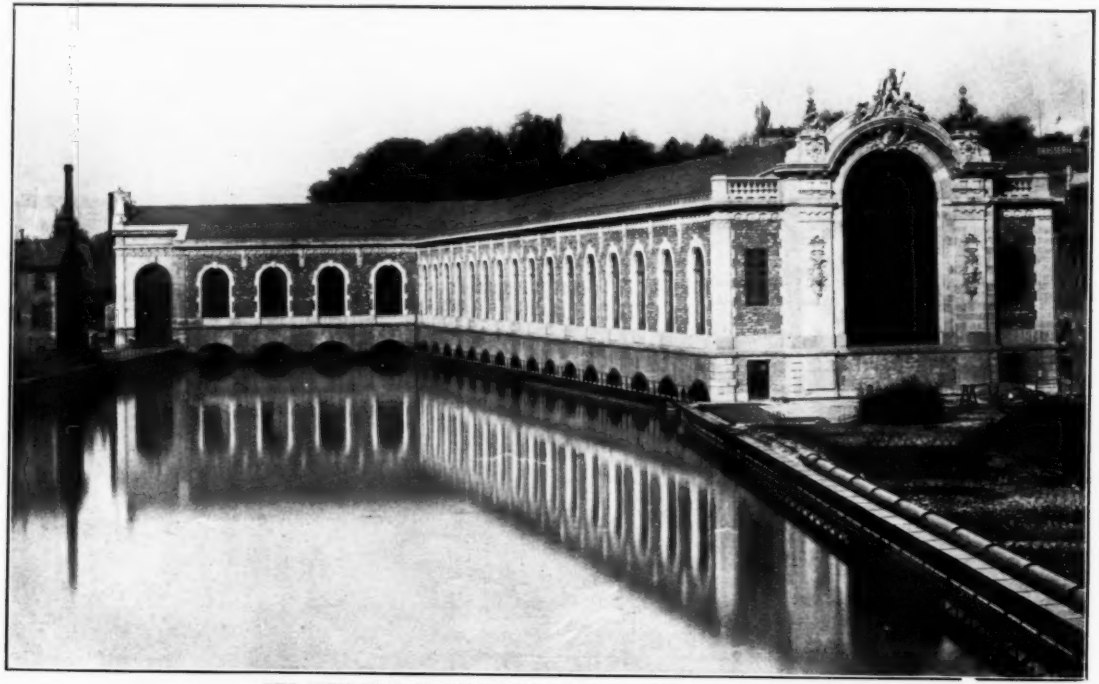
bottom of this shaft; it is 30 feet high, 40 feet wide, and 200 feet long. The penstock leading through the above mentioned shaft is 7.5 feet in diameter, and is connected, in the power house, to a horizontal distributing chamber of 10 feet diameter, from which impulse wheels are fed.

There are two additional shafts leading from the underground station to the distributing station at the banks of the river, one being utilized for the generator cables, the other for an elevator. Natural draft is established by the flow of water in the tail-race, causing good ventilation in shaft and generating room, which is perfectly dry and has a constant temperature of 55 degrees F.

In selecting a site for the power house the character of the soil must be given careful consideration; this may mean the shifting of the power house to a location other than originally determined upon. It is necessary that test holes be driven to ascertain the bearing power of the soil, and, if this is soft, it might be necessary to remove some of the upper layer and refill with better material thoroughly tamped. In such instance it is advisable to have one monolithic concrete mat covering the whole area of the power house. Where rock is encountered the bed of the excavation must be cleared of sand and loose boulders to give a proper bearing surface for the foundations. Piling is often necessary, and it has been the practice of late years to use concrete piling of various types.

The foundations are usually made of concrete: 1:2½:5 mixture for the smaller foundations, and 1:3:6 for larger foundations. Where exceptionally heavy foundations are necessary rubble concrete may be used in the interest of economy. Provision must be made for grouting, varying from one to two inches allowance according to the size of machinery to be set thereon.

Within the past few years rapid progress has been made in the design of hydroelectric plants, but, with few notable exceptions, nothing has been done as to the architectural features of the buildings for housing the machinery. Necessity requires only a building sufficiently strong to support and to shelter the machinery. The ultimate aim in the design of a hydroelectric plant is to generate electricity on a commercial basis. As a rule, these plants are located some distance from the centers of population, consequently the architectural features have been grossly neglected in the design of power plants, especially in America and Great Britain. This is quite the opposite to the practice on the Continent of Europe, where the consideration given to the architectural features of many plants is, from

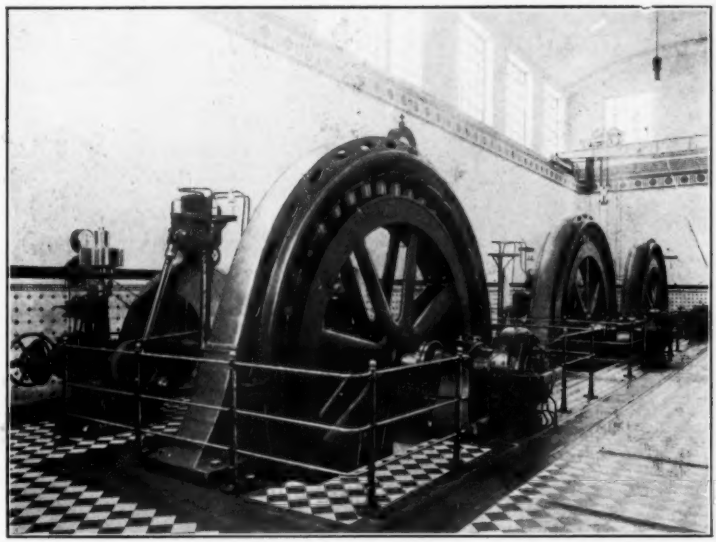


THE MUNICIPAL HYDROELECTRIC STATION, GENEVA, SWITZERLAND.

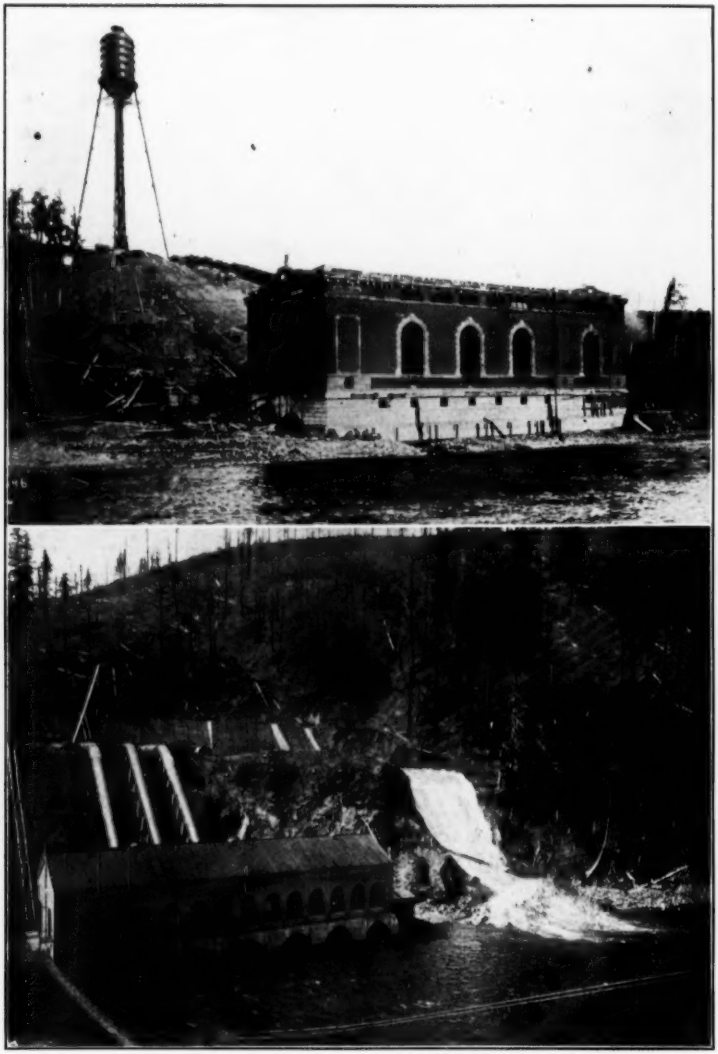
the American point of view, considered most exaggerated. From the Continental point of view, the architectural features of power plants are considered quite as important as those of private or municipal buildings. The same statement applies to the sanitary arrangements. It must not be lost sight of that a plant well designed as regards architectural features and sanitary provision will improve the *morale* of the operating force, and result also in a higher efficiency of the plant as a whole.

Some of the accompanying illustrations show what has been done in this direction on the Continent of Europe; comments are hardly necessary; they speak for themselves.

Many engineers as well as the general public have a biassed opinion as to the destruction of the scenery of the surrounding country by the erection of a power plant. This is an erroneous conception, as it may be seen from the illustrations that the beauty of the scenery of the surroundings of a power plant may be greatly enhanced. It merely resolves itself into a question of ability on the part of the designers to design a plant which will harmonize with the surrounding country, and it should be remembered, furthermore, that a pleasing appearance can nearly always be secured without adding to expense



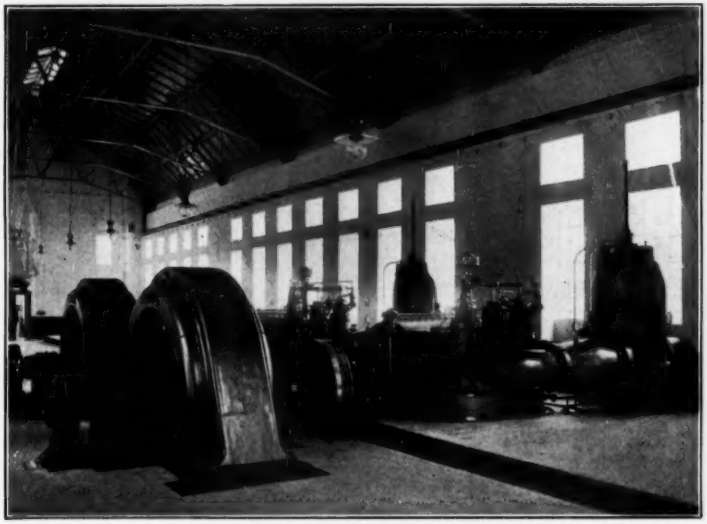
INTERIOR OF UPPENBORN PLANT, MUNICH, GERMANY. TURBINES OF 1887 HORSE POWER UNDER A HEAD OF 26 FEET.



TYPICAL AMERICAN HYDROELECTRIC PLANTS.
Above, the Great Northern Power Co., Duluth. Below, the Cazadero Power House, Oregon.

of the undertaking. In fact, many prominent plants which are masterpieces of ugliness have cost much more per unit capacity than others which are noted for their fine appearance.

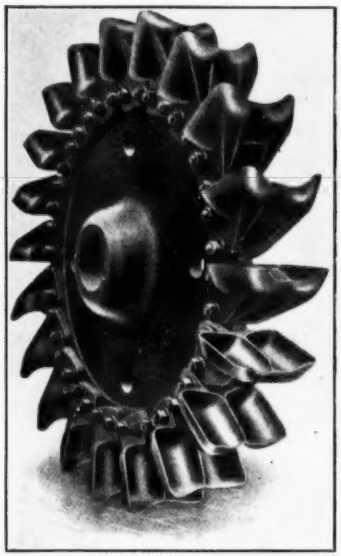
The superstructure should preferably be made fireproof, and particularly does this apply to the buildings containing the electrical equipment. Proper provision must also be made for heating and ventilation and, as pertains to the latter, louvres should not be located in the roof above the generators, as many types of louvres are liable to leak upon the generators or other parts of the electrical equipment, causing short circuits which might consequently result in serious interruptions of the service of the entire system. The same is true as to windows in the switching room, which must be fixed or provided with locking devices so that they cannot be opened. Experience has shown that many breakdowns have occurred from the sudden arising of storms and lack of time, or neglect on the part of operators, to close the windows.



INTERIOR OF SILL PLANT, INNSBRUCK, TYROL, EQUIPPED WITH 2,500 HORSE-POWER IMPULSE WHEELS.

Mechanical Equipment.

Turbines are divided into two general types—reaction and impulse—depending upon the action of the water. In the former the flow of water must be continuous throughout all parts of the turbine;



RUNNER OF A 5,000 HORSE-POWER PELTON WHEEL.

that is to say, the runner must be entirely submerged. In the impulse type the water impinges on parts of the wheel and in nearly all cases the atmospheric air has free access to the remainder of the runner.

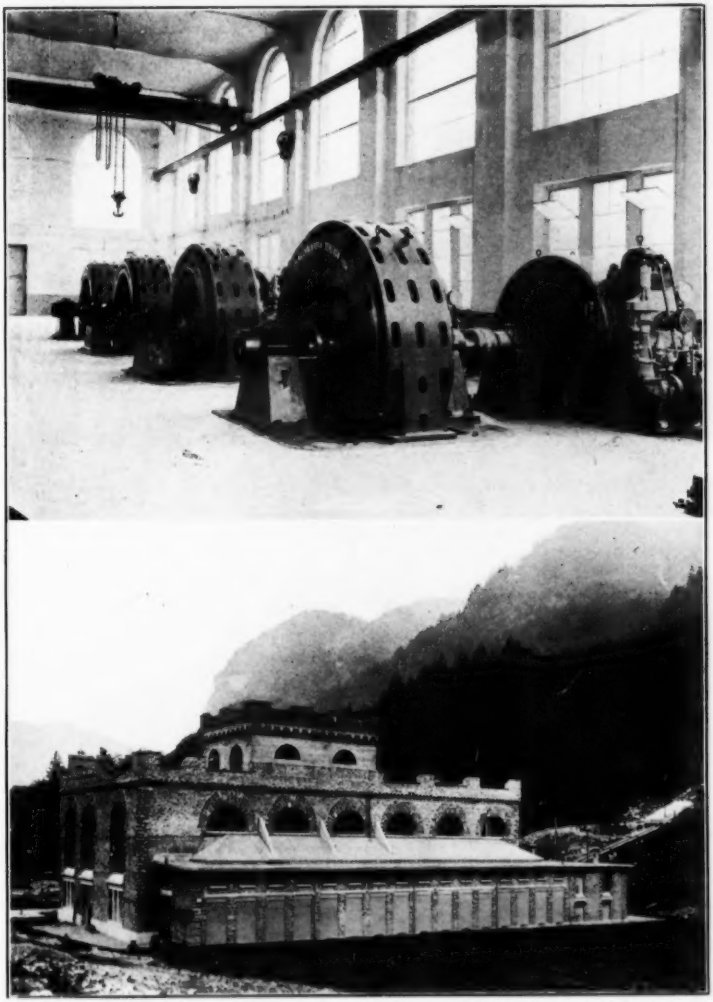
Turbines may be further divided, as regards their construction, into radial flow, axial or parallel flow, and combined or mixed flow. In the radial type the water passes through the wheel, either inward or outward, at right angles to the axis of rotation. In the axial turbine the general direction of the water is parallel to the axis of rotation. In the mixed-flow turbine the water enters radially and discharges axially, or *vice versa*. The different forms of reaction turbines are commonly known by the names of their inventors, as the Fourneyron, which is a radial outward flow; the Francis, a radial inward flow; and the Jonval, a parallel flow. A combination of the Jonval and Francis is known as the "American" type and is today the most common type in use in America where it originated.

Of the impulse type the Girard and the Zuppinger in Europe, and the Pelton in America, are the most familiar types. It might be of interest to state, as to the origin of the impulse wheel, that according to Professor Escher *(Zeitschrift des Vereines deutscher Ingenieure*, Feb. 18, 1905) Zuppinger installed the first tangential wheel at Weiler's Mills, near Frederichs Hafen on Lake Constance in 1846. This same engineer, according to L. Zodel *(Schweizerische Bauzeitung*, June 13, 1908) built for the Haemmerle Cotton Mills in Dornbirn, Germany, a tangential wheel in 1868-69 of 220 horse power, making 300 revolutions per minute under a head of 550 feet. This wheel was 5 feet in diameter, 30 inches wide, mounted upon a vertical shaft, and was provided with two diametrically opposite jets or nozzles. The highest efficiency of this wheel was 75 per cent.

The low-head turbines, which include the American turbine, are of the horizontal and vertical types and frequently a number of run-

ners are mounted upon a single shaft. They are sometimes placed in casings and at other times in open flumes.

Under medium-head turbines will be found a great variation of types, including high- and low-head, which is due to the fact, as previously stated, that the line of demarcation between low and medium,



A CONTINENTAL HYDROELECTRIC POWER STATION. INTERIOR AND EXTERIOR OF THE OBERMATT PLANT, LUCERNE, SWITZERLAND.

TYPICAL AMERICAN HYDROELECTRIC PLANTS.
Above, the Great Northern Power Co., Duluth. Below, the Cazadero Power House, Oregon.

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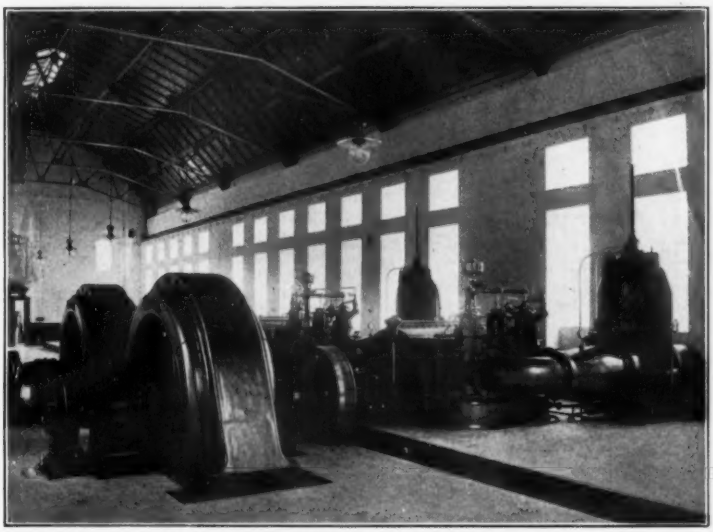

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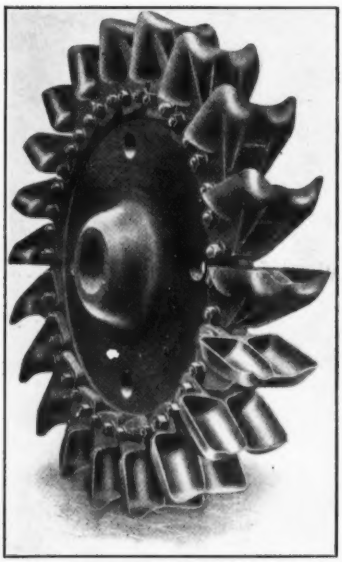


RUNNER OF A 5,000 HORSE-POWER PELTON WHEEL.

that is to say, the runner must be entirely submerged. In the impulse type the water impinges on parts of the wheel and in nearly all cases the atmospheric air has free access to the remainder of the runner.

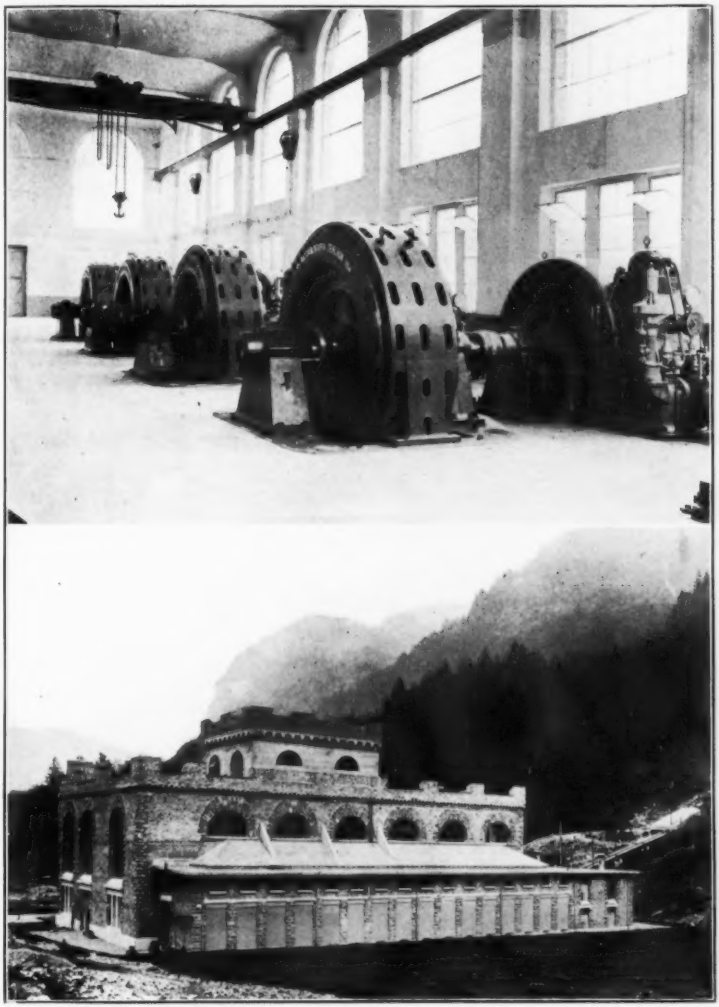
Turbines may be further divided, as regards their construction, into radial flow, axial or parallel flow, and combined or mixed flow. In the radial type the water passes through the wheel, either inward or outward, at right angles to the axis of rotation. In the axial turbine the general direction of the water is parallel to the axis of rotation. In the mixed-flow turbine the water enters radially and discharges axially, or *vice versa*. The different forms of reaction turbines are commonly known by the names of their inventors, as the Fourneyron, which is a radial outward flow; the Francis, a radial inward flow; and the Jonval, a parallel flow. A combination of the Jonval and Francis is known as the "American" type and is today the most common type in use in America where it originated.

Of the impulse type the Girard and the Zuppinger in Europe, and the Pelton in America, are the most familiar types. It might be of interest to state, as to the origin of the impulse wheel, that according to Professor Escher *(Zeitschrift des Vereines deutscher Ingenieure,* Feb. 18, 1905) Zuppinger installed the first tangential wheel at Weiler's Mills, near Frederichs Hafen on Lake Constance in 1846. This same engineer, according to L. Zodel *(Schweizerische Bauzeitung,* June 13, 1908) built for the Haemmerle Cotton Mills in Dornbirn, Germany, a tangential wheel in 1868-69 of 220 horse power, making 300 revolutions per minute under a head of 550 feet. This wheel was 5 feet in diameter, 30 inches wide, mounted upon a vertical shaft, and was provided with two diametrically opposite jets or nozzles. The highest efficiency of this wheel was 75 per cent.

The low-head turbines, which include the American turbine, are of the horizontal and vertical types and frequently a number of run-

ners are mounted upon a single shaft. They are sometimes placed in casings and at other times in open flumes.

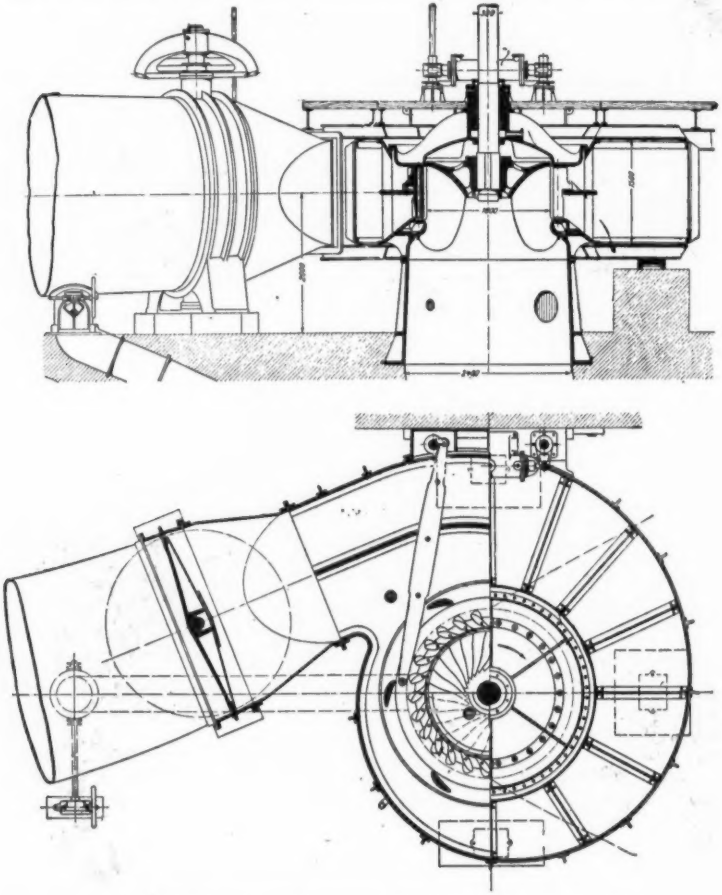
Under medium-head turbines will be found a great variation of types, including high- and low-head, which is due to the fact, as previously stated, that the line of demarcation between low and medium,



A CONTINENTAL HYDROELECTRIC POWER STATION. INTERIOR AND EXTERIOR OF THE OBERMATT PLANT, LUCERNE, SWITZERLAND.

and medium and high head, is not distinctly drawn. However, the majority of the medium-head turbines are of the Francis type, which are either of horizontal or vertical pattern with one or more runners mounted upon a single shaft. They are placed either in an open chamber of the power house or in a closed chamber or casing made of cast-iron or steel plates.

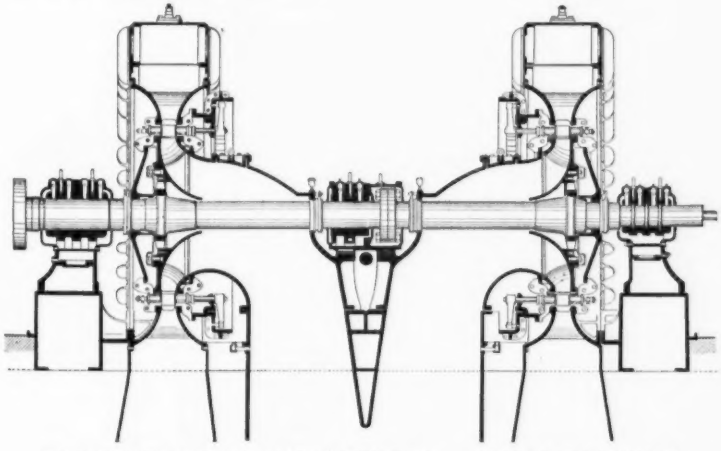
The figure below shows a vertical Francis turbine as installed in the Kykelsrud plant, Norway. It operates under a head varying from 52.5 to 62 feet, with a water consumption of 670 to 530 cubic feet per



VERTICAL-SHAFT FRANCIS TURBINE, KYKELSRUD PLANT, NORWAY.

second and at 150 revolutions per minute it develops 3,000 horse power. It will be noticed that this turbine, as is usual in this type, has a spiral casing. The water enters this casing at a velocity of 9 feet per second, which is gradually increased to 20 feet, and discharges with a velocity of 3.9 feet per second.

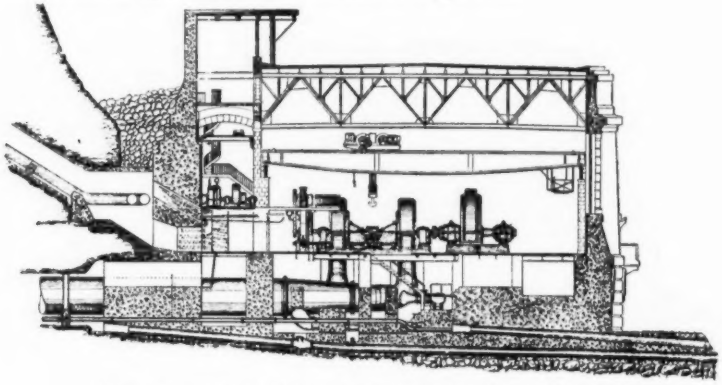
Below is shown the type of turbine in the Ontario Power Company's plant, designed to accommodate twenty-two turbines, of which ten are at present installed. They are of the horizontal Francis type, built by Voith, Heidenheim, Germany. Two turbines are mounted on a single shaft arranged so as to balance the thrust, one of the three bearings, however, being a thrust bearing. Each wheel has its own feeder penstock connection, the two wheels discharging into a common draft tube located between the two runners. These runners are of cast-steel and are 78 inches in diameter; the housing is of structural steel, rectangular in plan and spiral in elevation, the diameter being 16 feet. They operate under a head of 175 feet, 20 feet of which is secured by the draft tube, and develop 12,000 horse power at a speed of 187.5 revolutions per minute.



TWIN FRANCIS TURBINE, 12,000 HORSE-POWER, ONTARIO POWER COMPANY.

The Francis and impulse wheels are the universally used wheels of the high-head type. Probably the highest head developed is that at the Vouvry plant, near Lake Geneva, Switzerland, the head being, 3,116 feet. It may be of interest to state that probably the lowest head utilized is also found in this district, being 16½ inches.

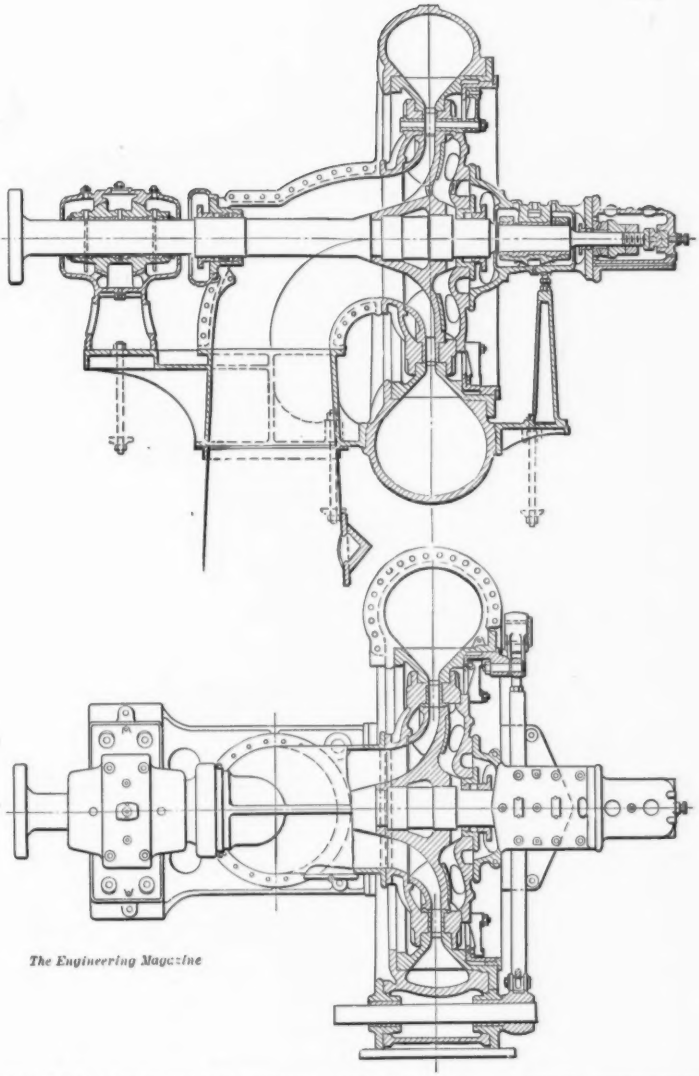
Of the high-head turbines used in America the most prominent type is the impulse, commonly called the Pelton wheel. This is a very simple machine; it consists of a wheel with a number of buckets mounted circumferentially. The wheel is usually mounted on a horizontal shaft, one or more on a single shaft. The water from the penstocks is directed against the buckets through one or more nozzles. Typical installations are those of the well-known Kern River plant of the Los Angeles Edison Company near Salt Lake City, Utah. In the latter case we find two wheels, mounted upon one shaft and enclosed in one casing, each wheel being provided with 24 cast-steel buckets, and operating under a head of 1,750 feet.



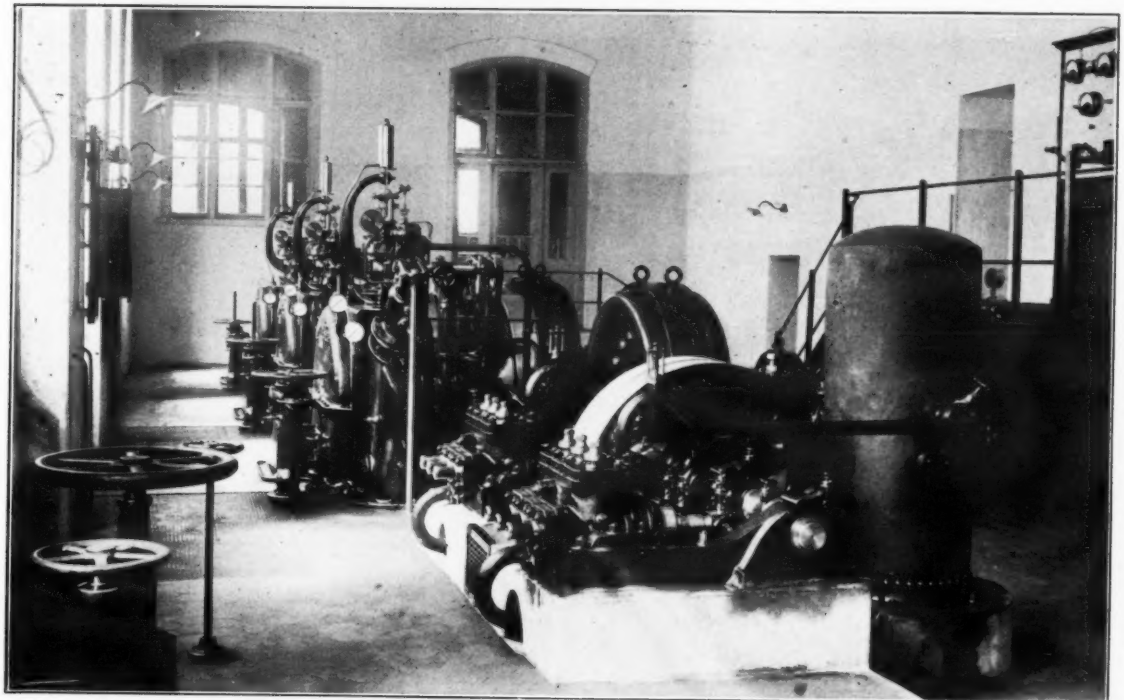
SECTION THROUGH POWER PLANT, ONTARIO POWER COMPANY.

As already stated Francis turbines are also used for high heads and page 357 shows a 9,700 horse-power turbine of this type as installed for the California Gas and Electric Corporation. It is designed to operate under a head of 550 feet, making 400 revolutions per minute. Until recently this turbine was known as the largest of this type ever constructed. However, 12,000 horse-power units have since been put in operation, and in the near future units of 17,000 kilowatts will be in service at the Rjukanfos plant in Norway. This plant, which is being built for the production of air-saltpetre (artificial nitrate), will have a first installation of five such units. It might be of interest to state that there is a great future for this product, for which several plants are already in operation and the ultimate aggregate capacity will soon reach 400,000 horse power.

Wherever possible, turbines should be provided with draft tubes when additional head can be thereby secured While it is not usual to provide impulse wheels with draft tubes, this may be done in con-



9,700 HORSE POWER FRANCIS TURBINE, CALIFORNIA GAS & ELECTRIC CORPORATION.



POWER PLANT AT CHUR, SWITZERLAND, EQUIPPED WITH IMPULSE WHEELS FITTED WITH DRAFT TUBES.

nection with small units, and we find an installation of this kind at Chur, Switzerland, where wheels of 250 horse power operate under a head of 272 feet, the head gained by the use of the draft tubes being about 15 feet When impulse wheels are so equipped the wheel must run in a partial vacuum, the water column in the draft tube being so regulated that the surface of the water in the draft tube is about 2 feet below the wheel. This is accomplished by providing the upper end of the draft tube with an air cock controlled by the governor.

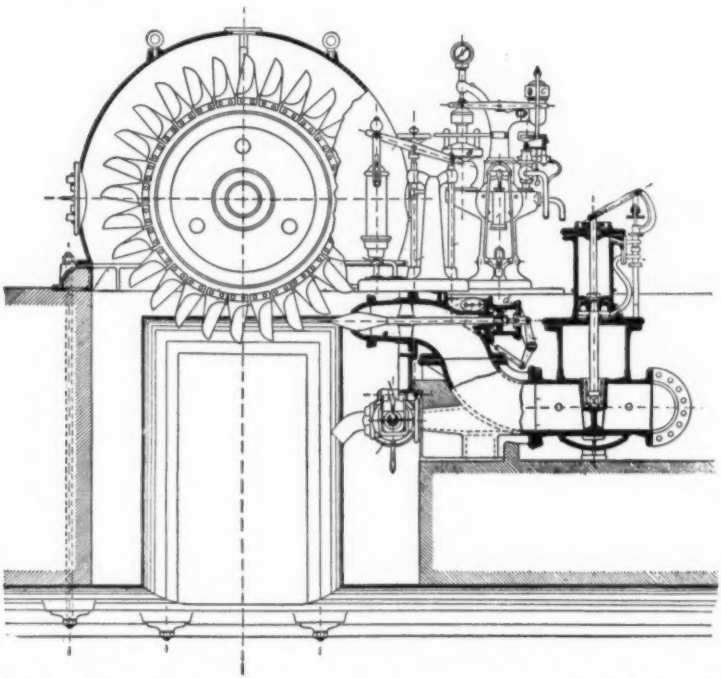
The theoretical height of head that can be obtained by a draft tube is 34 feet, equal to the pressure represented by a perfect vacuum. However, on account of frictional loss and leakage, the head obtainable in practice by the use of the draft tube is much less, and decreases with the increase of diameter and *vice versa*. According to Meissner, the practical heads due to draft tubes are as follows, the dimensions being converted into feet and given in round numbers:—

Diameter of Draft-tubes in Feet	Draft Head in Feet
2	27
4	21
6	17
8	14
10	12

Draft tubes should always be made conical, with the large end at the bottom, so as to reduce the velocity of discharge, and the upper end must be of the same size as the discharge outlet of the turbine so as to avoid abrupt changes in the velocity of the water. The velocity of discharge from the draft tube should be about 2 feet for low head, 3 feet for medium, and 4 to 7 feet for high-head turbines. All draft tubes should be as straight and free from bends as possible and the lower end must be water-sealed at least 6 to 12 inches for small-size and 18 to 24 inches for large-size turbines. They must be made strong enough to resist collapsing strain and must be properly anchored to avoid vibration.

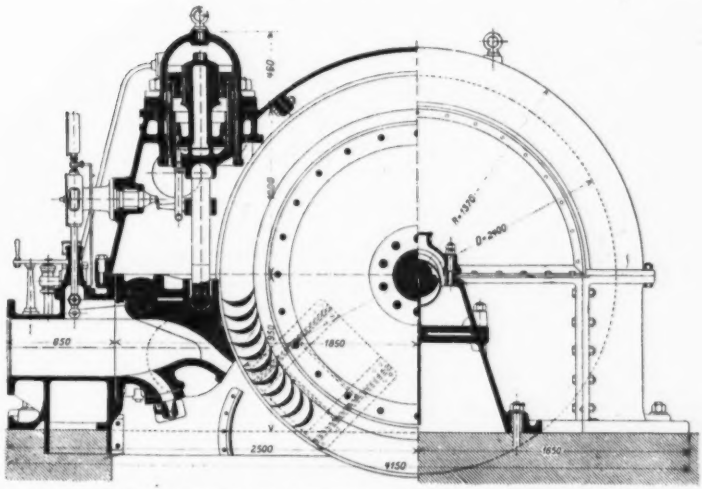
Turbines and water wheels, particularly when coupled to generators as is the case under discussion, must be provided with efficient governing devices to maintain a nearly constant speed. The irregular operation in hydroelectric plants may have its origin in the hydraulic end, because of water hammer, surging in the penstock or draft-tube, or loss of vacuum in the latter, etc.; in the mechanical end, because of poor operation of the turbines and the supply gates, or controlling of waste water in case of sudden shut-downs which might arise from

the hydraulic, mechanical, or electrical end of the station. There are, of course, other factors which may necessitate the choosing of a governor adapted to control load fluctuation for a particular plant; for instance, successful operation of a high-head plant may be accomplished in one case by a quick-acting and in another by a slow-acting governor. Where the load is steady a slow-acting governor gives the best results.



5,000 HORSE-POWER IMPULSE WHEEL WITH NON-WATER-WASTING NOZZLE AND GOVERNOR.

In addition to a governor, the turbine may be provided with a special fly-wheel. A good designer, however, considers a fly-wheel in connection with a turbine governor as an unnecessary adjunct, as the runner of the turbine or the revolving field of the generator should be designed to serve the same purpose. A plant with a great fluctuation in load is best controlled by quick-acting governors and such may be provided with auxiliaries to by-pass the water into the tail-race, as otherwise the sudden cut-off of the moving column of water will set up violent surges, and liability of damage to governor as well as pen-

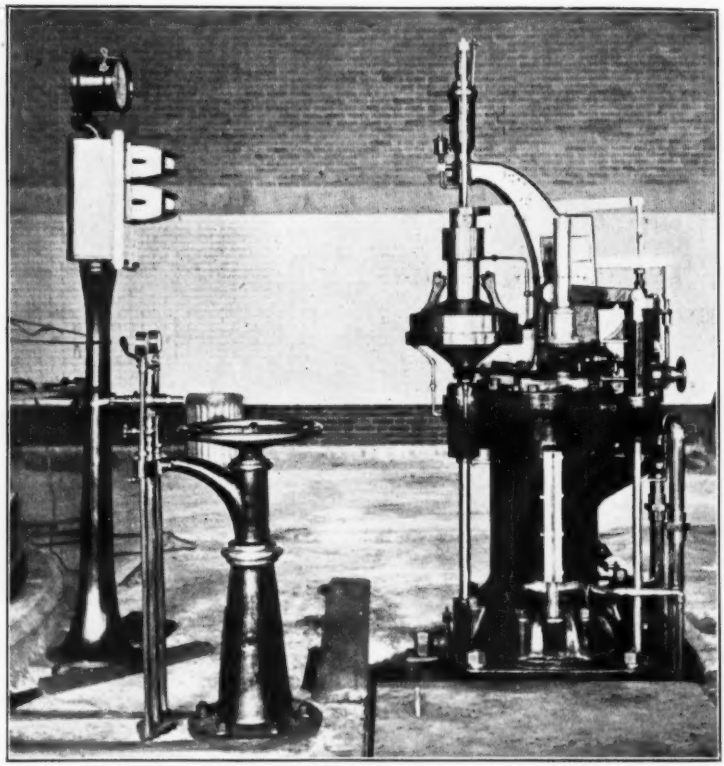


SPOON-WHEEL TURBINE AND GOVERNOR, OBERMATT PLANT, SWITZERLAND.

stock may occur. To prevent an excessive waste of water the governor should be designed to close the supply through this by-pass as soon as the shutting-off of the turbine is complete.

A governor of this type which has been installed in the Brusio Plant and also in many other prominent plants is shown on page 360. As will be seen the nozzle is stationary, while the needle is moved to and fro by a piston controlled by the governor which also actuates the by-pass located in the continuation of the penstock. The main valve closes simultaneously with the by-pass. The figure above is another type of Swiss governor used in connection with a so-called spoon-wheel turbine. It is operated by means of gearing from the main shaft and adjusts the opening of the jet by means of an oil-actuated piston device. The nozzle opening is 6 by 3.5 inches and the port opening is varied by a hinged jaw. The opening and closing action of the by-pass takes place simultaneously with that of the nozzle. As with the previously described governor, the closing of the main valve is by automatic action and can be accomplished in 20 seconds, while the action of the governor in throwing off the full load (2,500 horse power) requires 2 to 2.5 seconds, giving, after 6 seconds, a speed regulation of 4 per cent.

There are several more or less popular regulating devices on the market such as the Lombard, Pelton, Replogle and Glocker, etc. As



GLOCKER-WHITE GOVERNOR.

the operation of the Pelton governor is different from the European governors employed in connection with impulse wheels the mode of operation is here given.

The usual method of controlling the speed of a Pelton wheel is by means of a deflecting nozzle, needle nozzle, or a combination of both, the type most suitable for use depending upon the conditions of head, power, and character of load. The deflecting nozzle, provided with a ball and socket joint, is raised or lowered, thus throwing the stream on or off the buckets. The power of the wheel is increased or diminished accordingly as the load varies. A steel deflecting plate which deflects the stream itself is sometimes used to accomplish the same result when the design will not admit of a deflecting nozzle.

The needle nozzle consists of a nozzle body in which is inserted a concentric tapered needle, a change of position corresponding to a change in the discharge area of the nozzle.

Plants continue to be installed in which, when impulse wheels are shut down, the entire supply of water is directed from the wheel and wasted through the tail-race instead of being so controlled that this water may be stored or impounded behind properly designed dams as a reserve for dry seasons, thus doing away with the necessity of an auxiliary steam or gas-engine plant to meet such emergency. Wasting water in this way has another great disadvantage, inasmuch as this water, on account of the great force with which it is discharged into the tail-race or river below, will wash out the earth and endanger the foundations of the structure. At a notable installation in California such waste water is causing a considerable washout. This may be overcome by directing this waste water into the tail-race without having any injurious effect upon foundations through the washing away of surrounding earth. Such provision was made in connection with the Kern River Plant No. 1 at Los Angeles, by installing heavy curved deflector plates of steel so designed as to direct the water through two right angles before it is allowed to pass into the tail-race.

Power-plant designers should accept only such guarantee tests as are made in the power plant itself under the regular operating conditions. With such policy, which is strictly adhered to in Europe, higher efficiencies will be obtained in the future.

METAL-WORKING PLANTS AND THEIR MACHINE-TOOL EQUIPMENT.

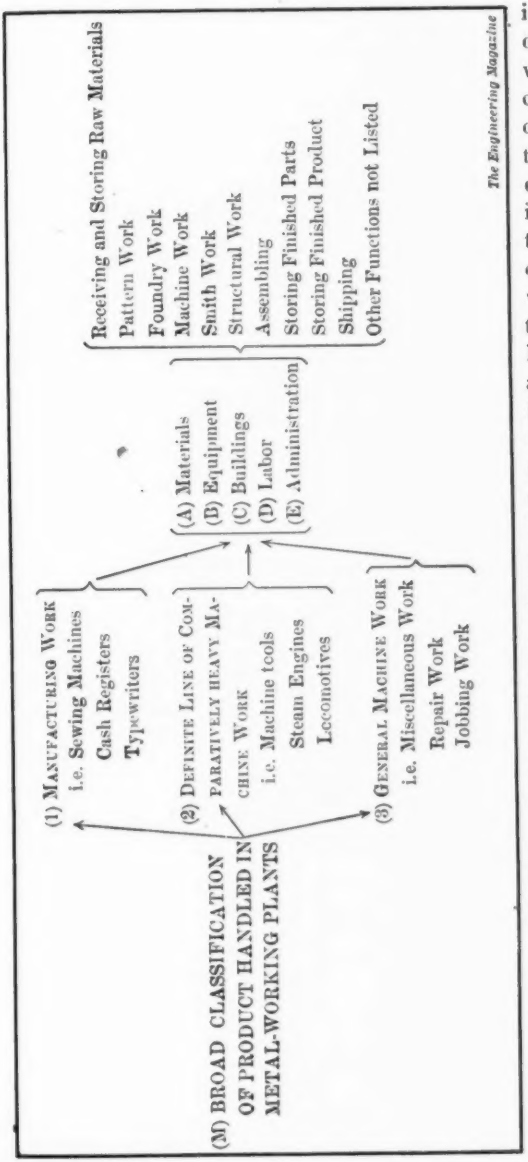
By Charles Day.

In this article and a second on the same topic, to follow next month, Mr. Day analyzes the machine-tool equipment of metal-working plants—not in detail, but in general character as influencing especially the design, layout and structural features of the buildings. This first part covers the general classification and the characteristics of general metal-manufacturing establishments. The July section will consider heavy and general machine-tool shops. —THE EDITORS.

IN four articles published in THE ENGINEERING MAGAZINE, September to December, 1909, the manner in which the work of planning and building industrial plants should be carried out was analyzed, formulated, and discussed. Consideration was given primarily to certain broad principles governing this work irrespective of the output for which the plant is designed. Knowledge of these principles is effective only when it is coupled with a thorough understanding of the special requirement of the particular business we are providing for. The next logical step in the development of this subject is, therefore, the study of the characteristics of the particular type of plant most interesting to the large majority of those concerned with the engineering industries. This is the plant whose predominant function is the working of metals.

Even here specific requirements vary widely in different branches of the metal trade. Conditions are not exactly the same in any two cases. Nevertheless, metal-working plants have well defined characteristics which can be classified according to the specific aims of the particular establishments included in the general category. I do not propose now to include in this group smelting or reduction of crude materials to metallic form, nor the making of castings; but only those manufacturing establishments and (more particularly) the machining departments, in which metals are converted into ultimate commercial products such as machine-tools, automobiles, sewing machines, electric generators, watches, etc.

The various kinds of plants under consideration will be divided into three groups, depending upon the character of their output (Chart 1, page 365). The nature of most metal-working businesses



is such that they do not fall wholly within the clear confines of any one of the groups, although in almost every case there is a predominating tendency toward one of them. It will be shown that the exactness of solution that can be attained when laying out a new plant differs in degree quite markedly for each of the groups, being a maximum in the first and a minimum in the third. A proper understanding of this condition results in a much clearer conception of the whole subject of metal-working-plant.

The conduct of all businesses coming under the classification in question involves five factors, *i. e.*, Materials, Equipment, Buildings, Labor, and Administration. Each of the departments or kinds of work

indicated to the extreme right of the chart comprises all of these factors, the names being merely indicative of the functions performed. This self-evident fact is alluded to only because it is the purpose to show that while machine work, smith work, the storing of parts, etc., are common to all of the plants coming within the classification, yet the manner of providing for and administering each of these has well defined characteristics which can be logically sub-divided for the purpose of analysis in accordance with the three groups given in the chart. These characteristics are briefly referred to below and can be identified by the letters and numbers corresponding to the divisions of the chart.

I wish to emphasize that this analysis is for the purpose only of setting forth some of the more important requirements of metal-working plants in a manner that may possibly prove helpful to the engineer engaged upon this work, through giving him a more comprehensive understanding of the limits attainable in the satisfaction of the conditions imposed by the principal branches of the metal-working industry.

M—(1) MANUFACTURING WORK.

(Characteristics.)

M (1) a—MATERIALS—Usually of such a character and required in such quantities that they can be readily handled and stored through the provision of special tote boxes, racks, bins, etc.

M (1) b—EQUIPMENT—Principally special in character; sometimes available as stock machinery, otherwise built to order in accordance with special designs.

M (1) c—BUILDINGS—Single-story or more often multiple-story—of types standard for such structures considered on their own account, the product not being an influencing factor.

M (1) d—LABOR—Comparatively low-grade help skilled in the performance of single operations, excepting a small part of the force composed of high-class mechanics.

M (1) e—ADMINISTRATION—Clearly defined conditions as to materials, equipment, and functions of employees permits of the most ready establishment of a fixed policy as to operating methods and provisions for expansion.

M (1) a, b, c, d, e—The problem of plant layout for industries in this group permits more readily of exact solution than for either of the groups that follow. Equipment is largely special. Buildings are of standard types suited to property conditions. Administration methods are capable of accurate definition, and standards can be adhered to owing to the repetitive feature of the manufacture. The final layout of equipment and buildings indicates directly (to a very considerable extent) the desired method of operation.

M—(2) HEAVY MACHINE WORK.

(Characteristics.)

M (2) a—MATERIALS—Usually comparatively heavy, quite diversified and bulky, so making the solution of handling and storing methods more difficult than for shops in the first class, although reasonably fixed conditions are presented.

M (2) b—EQUIPMENT—Generally stock machine tools, adapted to a considerable range of work as compared with the wholly special equipment characteristic of the first class.

M (2) c—BUILDINGS—Special to suit the size of the work performed in them, and incorporating structural features that are used in the same sense as equipment.

M (2) d—LABOR—A predominating part properly experienced in respective trades, not merely skilled in the attendance of machines performing single operations.

M (2) e—ADMINISTRATION—Conditions as to materials and equipment and functions of employees are not capable of standardization in the sense that is practicable in shops of the first class, so that intelligent direction of the work requires the constant application of scientific methods based upon elemental understanding of all factors involved and applied through carefully devised system.

M (2) a, b, c, d, e—The problem of plant layout for industries in this group is the most complex; for, while capable of reasonably definite solution, the greatest variety of factors is presented. Equipment is largely comprised of standard types of machines. Buildings are special. Administration is complex. The final layout of equipment and buildings suggests directly only in small measure the method of operation intended.

M—(3) GENERAL MACHINE WORK.

(Characteristics.)

M (3) a—MATERIALS—The character and amount of materials can be anticipated only in small part, owing to uncertainty of kind of work that will be done. Consequently, there is imposed a wide demand upon the receiving and stores departments.

M (3) b—EQUIPMENT—Principally stock machines suited to very wide range of work. Occasionally special machinery for possible repairs on special parts. Selection of types and determination of amount of equipment can be approximated only.

M (3) c—BUILDINGS—The character of work to be done is usually a governing factor in their design. Precise definition of types and sizes is, however, seldom practicable.

M (3) d—LABOR—Especially versatile in respective trades. Possibly not so capable at any one job as operators in shops of second class, but competent throughout a much wider range of performance.

M (3) e—ADMINISTRATION—The system of management must be the one that will prove most effective under circumstances that make it impossible to anticipate exact conditions from day to day. Each case must be worked out along special lines and often conditions are such as not to justify a highly perfected system.

GENERAL MACHINE WORK.
(Concluded.)

M (3) a, b, c, d, e—The problem of laying out plants coming within this group is capable of the least definite solution. Equipment is largely standard, suited to wide range of work. Buildings standard or special, depending on the kind of work that is desired. Administration methods must be suited to the uncertain conditions and, while in one sense the conditions call for the most highly perfected system, incidental conditions prohibit or do not justify their introduction. In any case, it is system that works from day to day and cannot plan for the future.

The purpose of classifying our subject in the manner given above was, primarily, to provide a logical basis for its discussion. We will now consider, individually, each of the factors composing the three principal groups.

M (1) a—MATERIALS—Usually of such a character and required in such quantities that they can be readily handled and stored through the provision of special tote boxes, racks, bins, etc.

The term "Manufacturing Work" is used in the customary industrial sense—namely, the kind of work that involves the making of certain articles in very large quantities, the repetition of various operations being the essence of the manufacturing feature. The necessity of manufacturing in such large lots as we have under consideration arises principally in connection with articles that are purchased for individual use, such as watches, cooking utensils, typewriters, sewing machines, etc. Of course, there are exceptions to this rule such as the automobile, but even in its case the actual manufacturing operations are performed upon comparatively small parts.

Consequently, materials purchased by manufacturing concerns are characterized by their comparative lightness and the fact that they are required in great quantities. Therefore, the stores department can be laid out with very considerable accuracy, providing special bins and racks for the storage of different material and they can be efficiently transported in lots through the use of tote boxes or other equipment adapted particularly to them.

M (1) b—EQUIPMENT—Principally special in character, sometimes available as stock machinery, otherwise built to order in accordance with special designs.

The types of special equipment used in manufacturing plants are designed ordinarily for the performance of but a single job, or in many cases, but for a single operation. Frequently, however, ad-

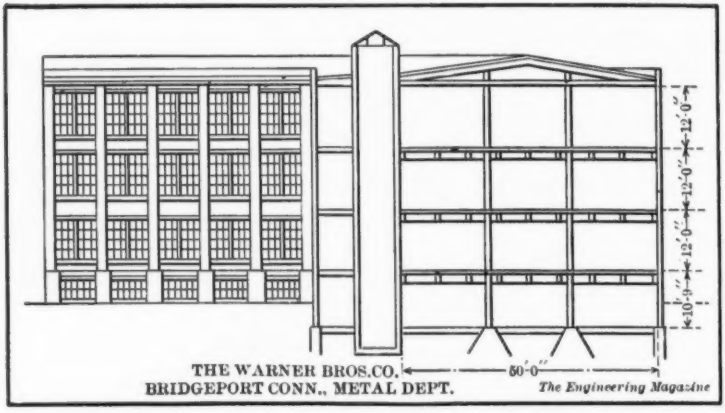
justments are provided which permit of the performance of other jobs or operations which are of the same general kind, but usually special equipment is used exclusively for the performance of certain fixed operations. There is special machinery for which there is so large a demand that it is a regular line of output of certain of the machine-tool builders; and then again, the machinery used to manufacture special articles which, either through patent protections or for other causes are made only by one or at the most a few concerns, must be built to order in accordance with special designs. The ability exercised in the design of such equipment has, necessarily, a very great bearing upon the efficiency of the plant, as the amount of output is directly dependent upon the performance of the machines themselves.

It is particularly in regard to equipment designed for the manufacture of articles for which there is a large demand that standard types have been perfected, the use of which can be counted upon when laying out a new plant. It is not practicable as a general thing for the engineer who is engaged upon such work to take under consideration the design of process apparatus or special machinery. Therefore, he is confronted with a very specific problem in so far as equipment is concerned.

M (1) c—BUILDINGS—Single-story or more often multiple-story—of types standard for such structures considered on their own account, the product not being an influencing factor.

Several functions are performed by the buildings used to house industrial work, the more important of which are; first, to afford protection against unfavorable weather; second, to allow of a floor area greater in the aggregate than the area of the property occupied (accomplished through the adoption of multiple-story structures); third, to afford fire protection; and fourth, to serve in part as equipment through providing the means of support for line-shafting, traveling-crane runways, etc. The first three considerations usually govern for the class of work that we are considering. As manufacturing work is light in character, the amount of head room between floor and ceiling that is required for proper light and ventilation (which is satisfactory for light overhead line shafts), is found to be adequate. Therefore, the building structures are not governed specifically by the detail processes of manufacture, but are types suitable for various other classes of occupancy. It is often desirable, from the standpoint of investment, to assure the fulfilment of this condition even if slight industrial disadvantages result.

The sketches below show buildings of multiple-story type suited to general manufacturing operations. The illustrations on following pages exemplify buildings belonging to the second and third groups in the classification here adopted—that is, to definite comparatively heavy machine work or to general machine work. They are shown here for comparison though their specific discussion will not be taken up until next month.



TYPICAL BUILDINGS SUITED TO THE REQUIREMENTS OF THE FIRST, OR "GENERAL MANUFACTURING," GROUP IN THE CLASSIFICATION ON PAGE 365.

M (1) d—LABOR—Comparatively low-grade help skilled in the performance of single operations, excepting a small part of the force composed of high-class mechanics.

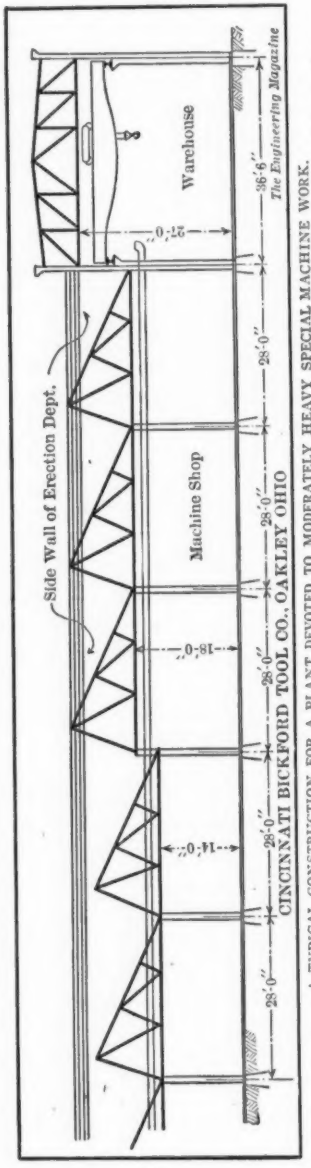
When the character of the work is such as to lend itself to manufacture by means of special and automatic machinery, highly skilled operators are usually needed only for the performance of certain auxiliary functions—that is, the special machinery may require attendants whose entire duty it is to furnish the work to the machine and to remove the finished product. While this may necessitate a considerable amount of dexterity upon the part of such operators, the work is of such a nature that comparatively low-grade help can be trained to a high point of efficiency. The great advantage these manufacturing methods afford is that quality and quantity of work done are almost wholly beyond the control of the machine attendants. As a rule the class of operators just referred to are more readily disciplined than skilled artisans. The question of their segregation arises only when it is necessary to meet objections that may be advanced by skilled workers.

The maintenance of conditions that permit the employment of low-grade men is made possible, however, only through the fact that a small force of very high-class mechanics is engaged to make all of the dies, jigs, templets and other special accessories, and conditions favorable to their most efficient performance must be established. It is often desirable to segregate these men, and when their work has to do with the product in only an indirect manner, their services are made available to a number of departments turning out products which in themselves are quite different.

M (1) e—ADMINISTRATION—Clearly defined conditions as to materials, equipment and functions of employees permits of the most ready establishment of a fixed policy as to operating methods and provisions for expansion.

The purpose of a system of administration is to provide the executive with means for securing the results for which the plant is operated; viz., the manufacture of a certain output complying with fixed standards as to quality and made in certain definite quantities.

The administration of manufacturing plants is facilitated through the fact that the quality of the product is governed largely by the performance of machines, not operators, and that a fixed output can be secured for a given equipment. Fixed output under uniform conditions of attendance should result in uniform operating costs; the



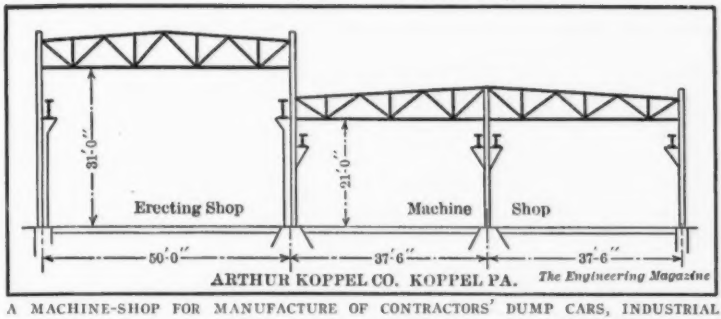
A TYPICAL CONSTRUCTION FOR A PLANT DEVOTED TO MODERATELY HEAVY SPECIAL MACHINE WORK.

A high bay for the warehouse department, one perpendicular to it for erecting large equipment, and large saw-tooth roofed area for machining departments.

costs being low because the volume of work justifies special equipment, and uniform on account of the regularity of the output.

Owing to the fact that in the main standard types of buildings are suited to manufacturing work, it is usually a comparatively simple matter to provide for extensions through the construction of additional units of the same character, although when new buildings are occupied there is usually required a reapportionment of space in the original plant.

Owing to the special character of the equipment, there is no doubt as to the work which must be performed upon it, and even though there are a great number of parts entering into the product, the question of routing is a comparatively simple one, and the routing plan that is adopted is to a considerable extent made apparent by the layout itself. This is illustrated in a very simple form by a hat factory, where, if the trucks transporting the hats are removed in the manner made directly evident by the arrangement of the machinery in departments, they will practically mark out on the floor of the various buildings lines identical with those shown on the routing diagram (to appear in a subsequent article) and this would be true if those who operated the plant had never seen the diagram in question.



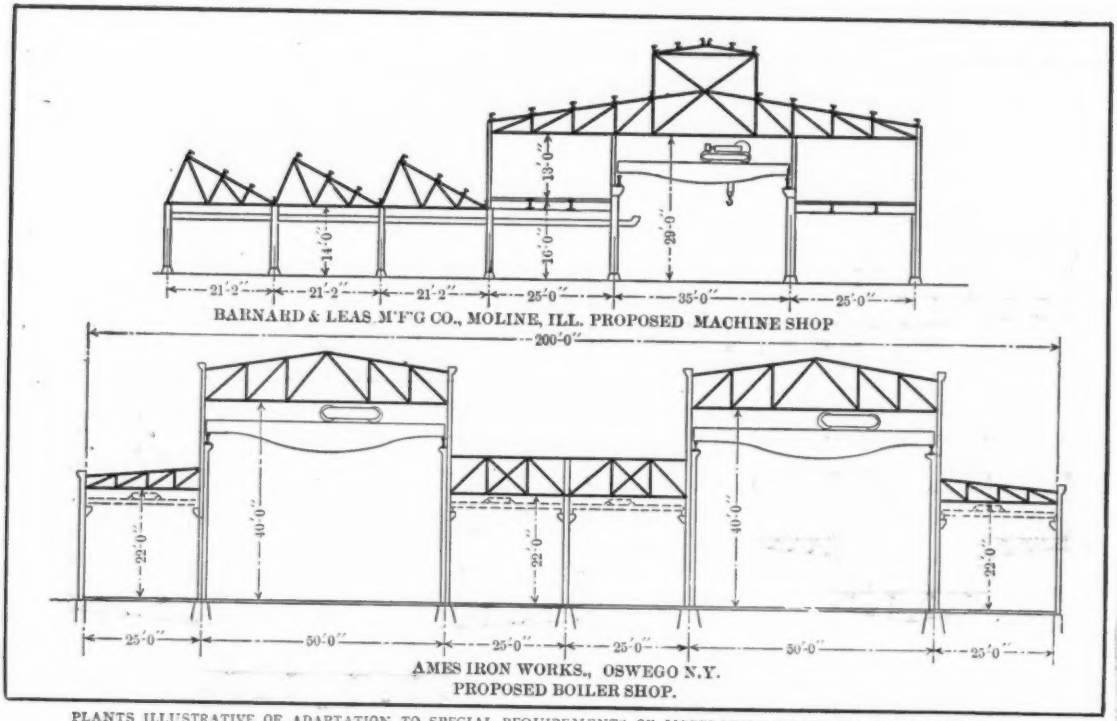
A MACHINE-SHOP FOR MANUFACTURE OF CONTRACTORS' DUMP CARS, INDUSTRIAL RAILWAYS, ETC. SPECIAL WORK OF MODERATELY HEAVY CHARACTER.

M (1) a, b, c, d, e—RESUMÉ.

Owing to the precision with which most of the fundamental requirements of manufacturing plants can be defined, it is clear that they can be laid out with a very great degree of accuracy. The performance of special equipment is absolutely definite in character. The amount of such equipment required can be calculated with precision, and the amount of enclosed floor space needed can be readily ascertained after layouts of equipment have been made. Except for the buildings themselves, the entire plant is special in character and, in fact, this is true to such an extent as to make the layout as a whole useful in connection with the manufacture of but a single line of output. The number of plants that can be classed properly in the group we are considering is rapidly increasing owing to the tendency toward specialization which has become so marked a factor within recent years.

There are so many kinds of special equipment, that it will not be practicable to include actual illustrations in this article,* particularly as many of them are familiar to the reader. The influence of the character of the work upon the types of buildings is, however, so very marked and interesting that a number of illustrations are given showing cross-sections of certain existing shops that have been designed for particular lines of metal work. The small metal parts for the corsets manufactured by The Warner Brothers Company of Bridgeport, Conn., in the buildings shown in cross-section on page 370, are turned out in sufficient quantities to secure the full benefit of manufacturing methods. This condition is also well exemplified in

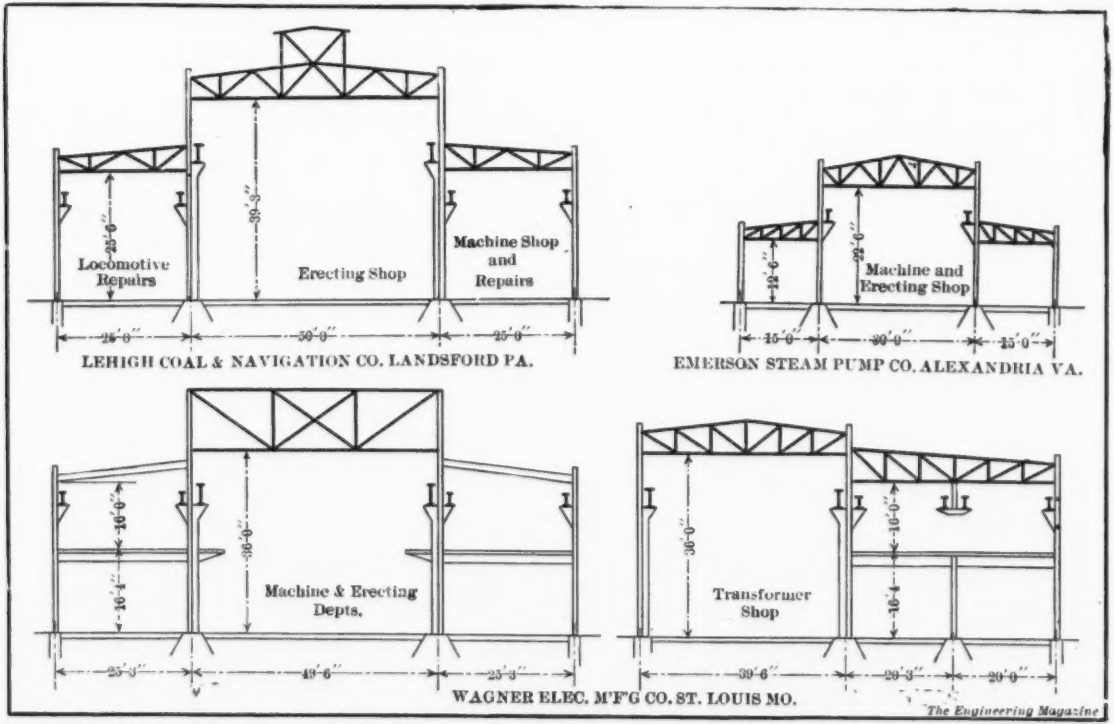
* Mr. Day dealt with machine-shop equipment in considerable detail in two articles that appeared in THE ENGINEERING MAGAZINE for July and August, 1909.



BARNARD & LEAS M'F'G CO., MOLINE, ILL. PROPOSED MACHINE SHOP

AMES IRON WORKS., OSWEGO N.Y.
PROPOSED BOILER SHOP.

PLANTS ILLUSTRATIVE OF ADAPTATION TO SPECIAL REQUIREMENTS OF MODERATELY HEAVY MACHINERY BUILDING.



THE LEHIGH COAL & NAVIGATION SHOPS BELONG TO THE THIRD CLASS—REPAIR AND JOBBING WORK; THE OTHERS, TO THE SECOND CLASS, OF SPECIAL MACHINE SHOPS.

Note the dimensional difference between the Lehigh Coal & Navigation and the Emerson Steam Pump Shops. Note also division of areas for machine and transformer work and provision of galleries for the lighter operation in the Wagner shops.

the building (shown in cross-section on page 370) in which have been housed certain of the principal departments of S. L. Allen & Company of Philadelphia, manufacturers of light agricultural implements. It is clear that the structures in question, which are of the multiple-story type, were designed primarily to provide the necessary floor areas in connection with the available property, but that it was possible to work up the structural details to satisfy building requirements upon their own account as the character of the work was not a governing factor. Thus it will be seen that these buildings could be used advantageously for other purposes than those directly intended, providing the floor areas were sufficient.

The concluding part of this discussion next month will take up buildings adapted to special and general machine work, with further reference to the illustrations of that type presented this month. These illustrations will be then introduced again for convenience of reference.

HYDRAULICS OF THE CHAGRES RIVER.

By Gen. Henry L. Abbot.

The real problem of the Isthmian Canal is one of hydraulics—not, as very generally assumed, merely one of navigation or finance. General Abbot's exact and authoritative studies, published in THE ENGINEERING MAGAZINE, were among the most important arguments leading originally to the selection of the right project. We are glad to be once more the medium of giving publicity to this paper, prepared at the instance of the National Academy of Sciences (April, 1910) answering affirmatively and emphatically the question, lately raised, as to the sufficiency of the water supply even with the huge locks provided by the present plans.—THE EDITORS.

IN projecting a canal across the Isthmus of Panama, the dominating element is not the volume of excavation at the Continental divide, but rather the hydraulics of the Chagres River whose valley must be traversed throughout the greater part of the route. The failure to appreciate this fact largely contributed to the disaster of the first French Company, and it is through the elaborate investigations of the New French Company, supplemented by those now in progress, that the problem has become perfectly understood. The climatic conditions are of primary importance in a study of the hydrology of the river, and they are so different from those of the United States that it is not without interest to contrast them.

The average annual temperature is about 80 degrees F., differing only about 2½ degrees in winter and summer. Ice and snow are unknown. The rainfall is much less irregular than with us, being largely governed by the motion of the sun in declination. The latitude of the Isthmus is about 9 degrees north, and as the sun moves north and south between the tropics it carries with it an ascending current of moist air which, condensed by cold, forms a rain-belt varying in latitude from month to month. Its passage over the Isthmus forms two well-marked seasons; three comparatively dry months, February, March, and April when the sun is far south; two intermediate months, January and May; and seven very rainy months forming the rest of the year. The absence of frost and the comparatively normal rainfall in this region greatly assist hydraulic studies.

It may naturally be asked what river in the United States, where the climatic conditions are so different, most nearly resembles the

Chagres in respect to volume of discharge, and thus illustrates the effect of these differences. The Roanoke River of North Carolina affords a good standard of comparison. Above Neal its drainage basin covers an area of about 87,000 square miles with an annual rainfall of about 51 inches. The studies of the New French Company included the basin of the Chagres above Bohio, where the projected dam was located, and where the stream at extreme low water nearly attains the level of mean tide. Above this point the drainage area is about 700 square miles, and the annual rainfall is about 112 inches. In respect to volume at ordinary stages the two rivers are very similar. Simultaneous gaugings in 1896, made respectively by the U. S. Geological Survey and the New French Company for five consecutive months, indicated almost identical discharges—about 5,800 cubic feet per second. The maximum recorded floods of the two rivers indicate 113,000 feet-seconds for the Chagres and 83,000 for the Roanoke, the height attained above low water being respectively about 40 feet and 30 feet. At low stages the Roanoke carries the larger volume—as might be expected since its drainage basin is more than twelve times as large.

The topography of the Isthmus also exerts a controlling influence upon the hydraulics of the river. The stream heads in the Cordillera de San Blas forming part of the Continental divide, which is here composed of ridges about 2,000 feet in height with peaks from 1,000 to 2,000 feet higher. The river is formed by two main branches, the Pequeni heading near the Atlantic coast in a massive limestone region, and the Chagres in the Continental divide where hard trap rock abounds. The upper tributaries flow through canyons cut deeply in the rock, with numerous rapids and falls. The two branches unite at Dos Bocas about 19 miles above Gamboa, where the line of the Canal is reached. In this distance the fall in water surface at low stages is about 80 feet, with many rapids. The channel is often bordered by limestone bluffs undercut by the torrents and passing gradually below the stratified sandstone of the lower river. The entire region is covered with a dense tropical forest. Near Gamboa the general direction of flow changes nearly at right angles, from south-west to north-west, and the river joins the route of the Canal. Here the low-water surface is about 46 feet above mean tide. At Bohio 20 miles below it hardly differs from that of mean tide, although the distance to the sea is about 27 miles. The tidal range on this coast is insignificant, varying between half a foot and two feet; but the fact that the river in the last 27 miles of its course has little or no energy in reserve to

transport its water to the sea, is one of the most important of its hydrology for canal purposes. The accumulation of water to supply the needful head causes Bohio to be the point where is noted in great floods the maximum rise, about 40 feet. Such natural conditions near the mouth are phenomenal. At New Orleans, 100 miles above the head of the Passes, the total range is only about 14 feet, to compare with 51 feet at Cairo more than 1,000 miles above.

Another peculiarity of the Chagres, which attracts the attention of an engineer, is the nature of the river bars—especially in the 11 miles of channel next above Gamboa. They differ widely in composition; some are of fine sand, others of pebbles, others of rounded stones three or more inches in diameter; there is little or no mixing of materials. The explanation will be found in the peculiar regimen of the river. In the dry season the Chagres is a gentle stream which, as we shall see, is largely fed by water percolating from the soil. In the rainy season its character is quite the reverse. The sudden cloudbursts upon the mountains, often lasting two or three days, create torrents in the smaller tributaries which uniting in the river bed pass down stream like great waves. In the narrow canyons of these headwaters the elevation of the water surface often attains heights of 40 or 50 feet in four or five hours. Several times the surveying parties were endangered by these rises, and indications were not lacking that in great floods they are largely exceeded. In the main stream the heights attained above low-water level are of course much less, but even here the volume carried may range in twenty-four hours from 2,000 to 40,000 or more cubic feet per second, with corresponding variations in transporting power which easily explain the sorting of the materials forming the bars.

Since 1883 automatic records have been made at Gamboa, showing hourly water levels, and their study has developed interesting facts. The normal height in the rainy season is about 10 feet above extreme low water, and the number and duration of the freshets above this height, year by year, afford a trustworthy estimation of the relative volumes carried and hence of the relative rainfall producing them. The annual average shows 19 freshets lasting 221 hours, ranging from 5 freshets lasting 37 hours in 1902 to 46 freshets lasting 709 hours in 1887. Furthermore the grouping of consecutive years is suggestive. From 1883 to 1894 inclusive, 12 years, the average annual number of freshets was 28, lasting 354 hours, while for the next 12 years it was only 10 lasting 86 hours. During the last two years the average has again increased, being 20 lasting 298 hours. It may

be added that studies of the rainfall records and measured discharges of the river are in perfect accord in confirming this progressive variation in annual rainfall and stream flow. During the operations of the first French Company the most unfavorable conditions were the rule. Heretofore the American engineers have been specially favored, but the latest records suggest that a change may perhaps be apprehended in the near future. Excessive rainfall of course is unfavorable to rapid excavation and concrete laying. During last year the number of freshets was considerably above the average, being 27 lasting 466 hours, but it may be noted that they did not materially retard progress.

Aside from these considerable freshets, great floods are a characteristic feature of the regimen of the Chagres. They also occur periodically. The first of record since the opening of the Panama Railroad in 1855 occurred in 1879, and inundated all the low lands of the valley. Four more occurred between 1885 and 1893, these 9 years being included in the period of excessive rainfall; 12 years of exemption followed; since then two great floods have occurred, one in 1906 and the other in 1909. These floods are always of short duration, hardly exceeding 48 hours, but they carry immense volumes and submerge large areas in the lower valley.

The close vicinity of the route of the Canal to this turbulent river; the fact that near Gamboa its bed is about 45 feet above mean tidal level, demanding a complex system of dams and artificial channels to protect a sea-level canal against inundation, and the further difficulties caused by the excessive tidal range in the Bay of Panama, which may equal 20 feet twice daily, early convinced the engineers of the New French Company that a sea-level construction was out of the question, and that the Chagres must be regulated by a great artificial lake to be entered by shipping by means of locks, the only manner by which the torrential neighbor can be perfectly controlled. This decision entailed an elaborate study of the hydraulic conditions on the Isthmus in connection with the question of water supply for lockage in the dry season. The discharge of the river was regularly gauged, beginning in 1890, and a fund of information now of great value to American engineers was collected. Time does not permit even a summary of these hydraulic investigations, but one matter of interest from a scientific point of view may be considered, namely the ultimate disposition of the rainfall.

As is known to every one, of the rain which falls upon the surface of the earth one part flows directly to the sea through the channels

of the rivers; another part soaks into the ground, of which much the larger portion gradually percolates to the river beds and thus reaches ultimately the same destination while the remainder is consumed in the subterranean chemical changes in progress; the third part is returned to the atmosphere by evaporation, either directly or through the medium of plant consumption. The relative percentage of these three parts has an important bearing upon the question of the water supply of a canal with locks, and was the matter to be elucidated. Many streams are known to receive large volumes of water by percolation through the ground, the amount depending largely on the geological character of the soil. The absence of frost and the exceptional regularity of precipitation on the Isthmus specially favor the study of this element of the problem.

The daily outflow at Alhajuela, Gamboa, and Bohio had been carefully gauged during about six years. The catchment basin above the latter covered an area of about 700 square miles, divided into three sub-basins of known area in which the average rainfall varied somewhat, but where a sufficient number of observing stations had been occupied to afford a fair knowledge of the relative and absolute precipitation in each. These data permitted a satisfactory analysis of the ratio between downfall and outflow throughout the entire district—the gauged outflow being of course transformed from the usual unit of cubic feet per second to the height in inches to which one square mile of surface would be covered by the flow, thus giving figures directly comparable with the rainfall in inches.

The resulting values of the ratio month by month revealed the laws governing ground-water flow. It was found that the minimum value, about 0.3, occurred in May; and that from that date the ratio regularly increased month by month to about 0.75 in November, when both rainfall and outflow are at their maximum. It then rapidly passed to fictitious values above unity, indicating an outflow larger than the rainfall; and so continued, reaching a maximum of about two units in February, to a date between March and April when it dropped rapidly to the minimum in May.

The explanation of these figures is manifest. The soil acts like a sponge; at the end of the dry season the subsoil water reserve has nearly or quite drained out adding little or nothing to the river flow; during the following rainy months its volume gradually augments, discharging more and more through the river bed, until when the dry months arrive its contribution constitutes by far the larger part of the entire flow. The determination of the numerical values of the ratio,

month by month, permits an easy computation of the actual volumes of the ground-water flow. The annual average represents about one-third of the total rainfall. In round numbers the general results of the study indicated for each square mile of this tropical river basin an annual rainfall of 111 inches; a total outflow including ground water of 73 inches; and a surface evaporation, represented by the remaining rainfall, of 38 inches. As compared with the north-eastern portion of the United States these figures indicate about two and a half times the precipitation, three and a third times the outflow, and one and a half times the surface evaporation.

Since the American operations began, the same system of careful observations has been continued, with a large increase in the number of the rainfall stations; another six years have now passed, and it is not without interest to submit the records to the same analysis and thus to compare the results. This I have done, and find the accordance to be so extremely close that it suffices to present in tabular form figures showing the average results for the past twelve years. As all but the last year or two pertain to the minimum period of the progressive variation in rainfall, deductions from them in respect to the water supply of the Canal are certainly safe and conservative.

The available volume is demonstrated to be more than adequate, even with the immense locks provided for the accommodation of modern shipping.

RAINFALL AND OUTFLOW ABOVE BOHIO, 700 SQUARE MILES. TWELVE YEARS, 1898 TO 1909 INCLUSIVE.

Months.	Rainfall inches.	Outflow inch-mls.	Ratio.	Outflow in feet-seconds. Total.	Direct-flow.	Ground-water.
January	4.55	5.74	1.26	3477	828	2649
February	1.18	2.40	2.03	1612	238	1373
March	1.16	1.61	1.39	979	211	768
April	3.77	2.05	0.54	1284	713	571
May	11.45	4.13	0.36	2509	2090	419
June	11.30	5.73	0.51	3592	2114	1478
July	13.75	7.29	0.53	4425	2504	1921
August	13.47	8.14	0.56	4940	2646	2294
September	11.27	8.07	0.71	5055	2136	2919
October	13.63	10.01	0.74	6074	2463	3611
November	18.25	14.19	0.78	8904	3425	5479
December	8.13	10.70	1.31	6499	1488	5011
Year.	111.91	80.06	0.71*	4113	1738	2374
Dry (3)	2.04	2.02	....	1291	387	904
Rainy (9)	11.76	8.22	....	5053	2188	2865

* Quotient of aggregates.

Having by actual measurements, and by deductions therefrom, reached a precise valuation of the probable monthly downfall and outflow from the catchment basin above Bohio, ground water included, it remained to consider the third element of the lock canal problem—the probable evaporation from the projected lakes. No direct observations to determine evaporation from exposed water surfaces had been made on the Isthmus; but they had been made on Lake Nicaragua for ninety-four months by the Walker Commission, indicating an average of 0.18 inches per twenty-four hours. That evaporation from the general surface of the country must be less than that from exposed water surfaces is certain; but the fact that rain falls at Bohio on 254 days out of the 365 days of the year, and at Gamboa on 204 days, (averages based on eleven years of records) would indicate that the difference between the two is probably not very material in this tropical region. At any rate a check upon the Nicaragua observations might be had by assuming that the residue of the rainfall after deducting the total outflow would represent the evaporation from the general surface of the country. This computation could not be made month by month, because the rate of flow of the ground water in reaching the river bed is unknown; but the mean annual figure representing a complete cycle is not affected by this circumstance. It indicated a loss by evaporation per square mile over the entire surface of the catchment basin above Bohio of 0.11 of an inch per twenty-four hours.

During the last three years direct evaporation measurements on exposed water surfaces have been made by the Commission—for two years at Bas Obispo near the middle point of the Isthmus, for two years at Cristobal on the Atlantic coast, and for two years at Ancon near the Pacific coast. The figures differ but little at the three stations, and may be thus summed up, expressed in inches evaporated per 24 hours.

	Annual.	Dry months (3)	Rainy months (9)
Atlantic coast	0.114	0.228	0.100
Central district	0.141	0.185	0.122
Pacific coast	0.117	0.178	0.091
Averages	0.124	0.197	0.104

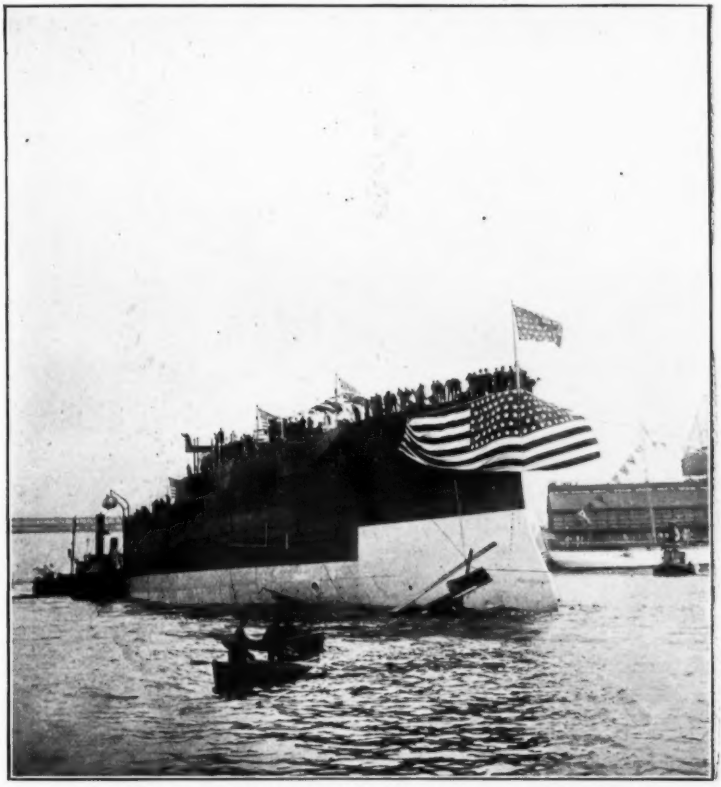
The general accordance between figures reached by so different methods is certainly striking; and the fact that the new measurements show that evaporation in the three comparatively dry months is nearly

double that in the rainy season is a further confirmation of their accuracy, and incidentally of the value of the method of analysis by the use of the ratio between rainfall and outflow. It may be added that the latter when applied separately to the catchment basins above Gamboa and Bohio indicated a small escape by percolation under the dam site at the latter place, a fact confirmed by borings. Unfortunately the application of this method in temperate regions is rendered difficult by reason of complications introduced by ice and snow, and by the more irregular rainfall. In fine, on the Isthmus it may be considered as well established that of the total volume of the rainfall about one-third escapes directly through the beds of the streams, another third finally reaches the sea by the same channels as ground water, and the remainder returns to the atmosphere by evaporation.

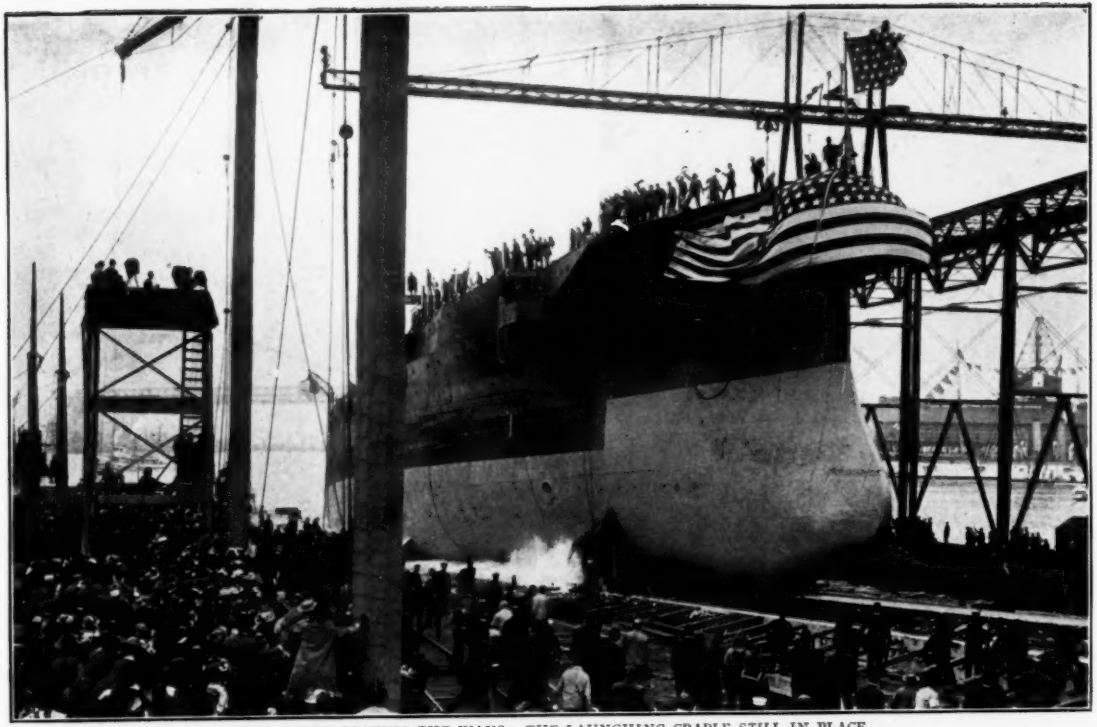
THE UNITED STATES BATTLESHIP FLORIDA.

LAUNCHING OF THE NEWEST AND LARGEST VESSEL IN THE U. S. NAVY.

The pictures on the following pages illustrates some of the most interesting incidents at the launching of the Florida, which was "put overboard" at the New York Navy Yard on May 12 at 11.21 a. m. The ship is offered as the finest example of construction by the Navy Department itself. She is 521 feet 6 inches long, 88 feet 2½ inches beam, 28 feet 6 inches mean draft, 21,825 tons displacement. Her main battery is ten 12-inch, and sixteen 5-inch guns, her speed 18 knots. As launched, she was 68 per cent completed.



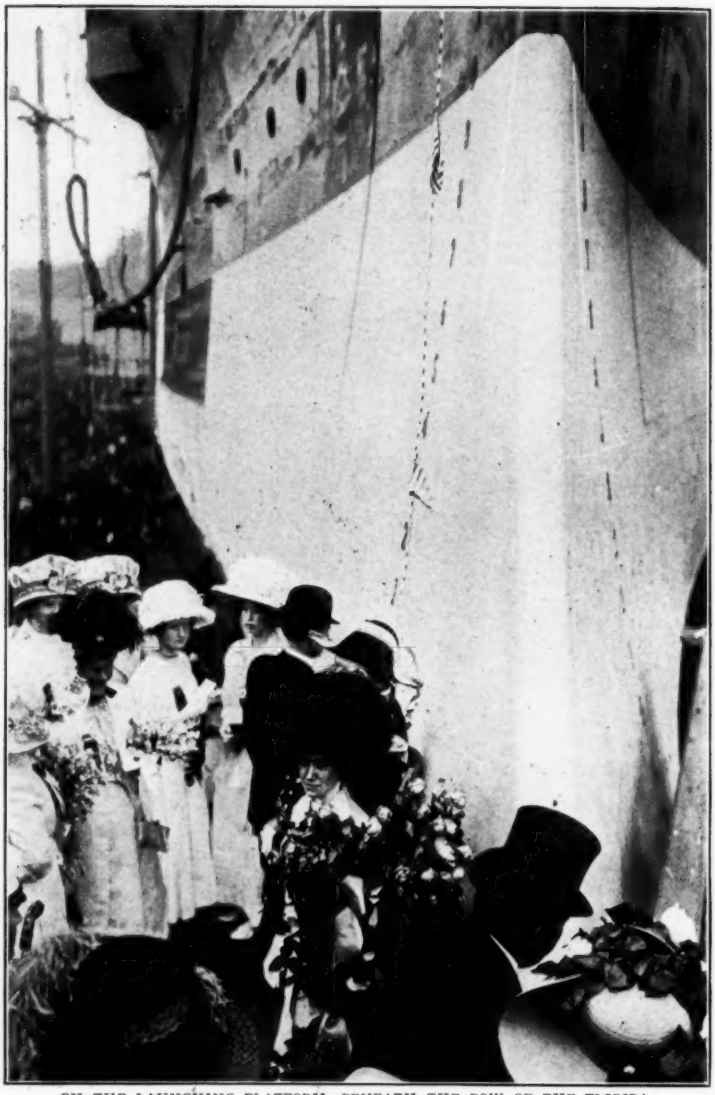
THE FLORIDA FAIRLY AFLOAT, IMMEDIATELY AFTER THE LAUNCH.
Parts of the launching cradle are afloat alongside. The tugs are just taking her in tow.
Photographed by Edwin Levick, N. Y.



JUST BEFORE LEAVING THE WAYS. THE LAUNCHING CRADLE STILL IN PLACE.
Photographed by Edwin Levick, N. Y.

THE CROWD BEGINNING TO BREAK UP AFTER THE LAUNCH.

The launching ways are on the extreme left, the sole pieces that were sawed off to release the ship being near the furthest stairway. The launching party were on the high platform in the left background. Photographed by Edwin Levick, N. Y.



ON THE LAUNCHING PLATFORM, BENEATH THE BOW OF THE FLORIDA.
Miss Fleming, the sponsor, is in the center of the picture. The bottle was swung by the flag-decked cord. Photographed by Edwin Levick, N. Y.

HUMIDIFIERS, THEIR PRINCIPLES AND USEFUL APPLICATIONS.

By Sterling H. Bunnell.

The theory and practice of humidification are to certain extent controversial. Mr. Bunnell's statement is made from the standpoint of the "Evaporative school," but the criticism of leading representatives of opposing schools has been invited and their suggestions, so far as practicable, have been incorporated. The purpose of THE ENGINEERING MAGAZINE is to foster interest in a subject of large importance to the efficiency of operation in many lines of manufacture—larger importance than is yet generally realized.—THE EDITORS.

THERE are many materials, operations, and products which require special atmospheric conditions for advantageous or profitable maintenance. Principal among such operations is the manufacture of textiles, perhaps the largest single industry carried on in factories. In the favored climate of the Lancashire and Bolton districts of England, the natural climate affords working conditions equalled in America only on occasional days in certain localities. Even in England, however, there are many days in which the atmosphere is too dry for the best work. Since textile fibres are increased in strength and elasticity by high humidity and moderately high temperature, breakages are less frequent under proper conditions, and the output is increased. But even before the fibre reaches the manufacturing plant, atmospheric humidity plays an important part. Cotton loses weight as it dries out; but more than that, the fibres bristle and appear shorter and of lower grade than when slightly moistened. Leather, feathers, and many other porous substances lose a considerable percentage of weight in drying out; so that the maintenance of average and uniform humidity in the storage rooms has a direct advantage to the owner in maintaining the value of his goods as they lie in the warehouse. Cigars and tobacco lose flavor in dry air, and regain it to some extent, after loss, by storage in properly humidified rooms. Wooden furniture, and musical instruments, are sometimes cracked or the finish injured, by the dry air of steam-heated rooms. All these and other similar goods are advantageously worked or stored in rooms in which the atmospheric humidity is artificially controlled and kept at the most desirable point.

Ideal conditions may be found naturally in certain favored locations or climates. In other places, they must be produced by artificial

methods. Heating the air in the workroom to promote the comfort and health of the operators, and therefore to increase their output, is the original idea from which has sprung the modern system of providing extensively for comfort and even luxury in factories. Heating apparatus, however, provides against only one of five undesirable atmospheric conditions—deficiency in temperature. The others are excess of temperature, excess, or deficiency, of contained moisture, and the presence of foreign matter such as dust or deleterious gases. Temperature and humidity are inter-dependent, so that a change in one is likely to involve a change in the other; in many cases, apparatus must be provided to control both conditions simultaneously in order to provide the best working atmosphere.

There is a certain fixed quantity of water vapor that can be carried by a cubic foot of air at a given temperature and atmospheric pressure. This quantity increases with the temperature. Air carrying its full contents of moisture is said to be "saturated," for the injection of a further quantity of vapor will cause the condensation of an equal amount into cloud, fog, or mist, formed of minute drops of water suspended in the air. Heating the air thus over-saturated, which increases its capacity for moisture, will be followed by evaporation from the surfaces of the drops, until the mist disappears. With regard to its temperature, air saturated with moisture is said to be at the "dew-point," since the slightest fall of temperature will decrease its capacity for carrying water vapor, and be followed by the condensation of the excess upon the surfaces of solid objects. If the condensation takes place upon the dust particles floating in the air, mist appears. It is in this way that clouds and rain are formed in the upper atmosphere of the earth. Air which is saturated with vapor or "at the dew-point" is said to have a humidity of 100 per cent; with less than saturation, the ratio of the quantity of moisture present, to the total quantity which can be carried at the given temperature, is expressed in a percentage; thus air at say 60 degrees having half its possible quantity of moisture, is said to be at 50 per cent humidity.

Since the quantity of vapor required to saturate a cubic foot of air increases with the temperature, it follows that heating air, which increases its capacity for moisture while its contained moisture remains the same in quantity, will decrease the relative humidity. Similarly, decreasing the temperature of air containing moisture increases its relative humidity. Furnace or steam-heated air, being warmed without increasing its moisture content, is relatively dry, and increases the rate of evaporation from moist surfaces, as in

drying kilns. Evaporation is increased to an undesirable extent in houses and offices, where wooden furniture is dried out and cracked, and human beings subjected to a surface-drying process which accentuates the effect of each temperature variation and increases the chances of "taking cold." Refrigerated air, on the other hand, becomes relatively more humid, and if the cooling process is carried through more than a few degrees, the air reaches the saturation point and the excess of moisture is deposited on the cooling pipes and all solid objects, or condensed as mist upon the dust particles.

The principles governing the disappearance of heat in the evaporating process, the heat becoming latent in the vapor, and its corresponding reappearance in the process of condensation of vapor into liquid, are generally understood. It follows that a decrease in atmospheric temperature sufficient to reach the dew-point and cause condensation of vapor, will cause the liberation of latent heat tending to check the fall in temperature. Conversely, the injection of water sprays into the air for the purpose of increasing the humidity will cause the loss of sensible heat as the spray-drops evaporate. In every humidifying process, it is necessary to consider the effect of temperature, both in its relation to the actual evaporation of the moisture, and with regard to the alteration of relative humidity by subsequent changes in temperature.

The most obvious method of increasing atmospheric humidity in a factory or warehouse is by the direct admission of steam. The device used is of the simplest, consisting of a small valve, set by hand, and a receptacle to catch drip. As the water is already in the form of vapor, there is no latent-heat effect to be considered. Since the specific heat of steam is low, the heating effect on the air due to the cooling of the relatively small quantity of vapor is for many purposes unimportant. If, however, a humidifying process is to be used for workrooms in hot, dry weather, even a small increase of atmospheric temperature is intolerable. In textile mills, the use of "steam-pots" for humidifying, once approved practice, is today considered almost archaic. Rotting woodwork, wet and rusting machinery, uneven and fluctuating humidity, and discomfort and disease for the workers, have formed a strong combination to increase operating expense and decrease profits. The steam-pot will therefore eventually disappear from the few remaining mills using it, as soon as finances permit the purchase of modern equipment.

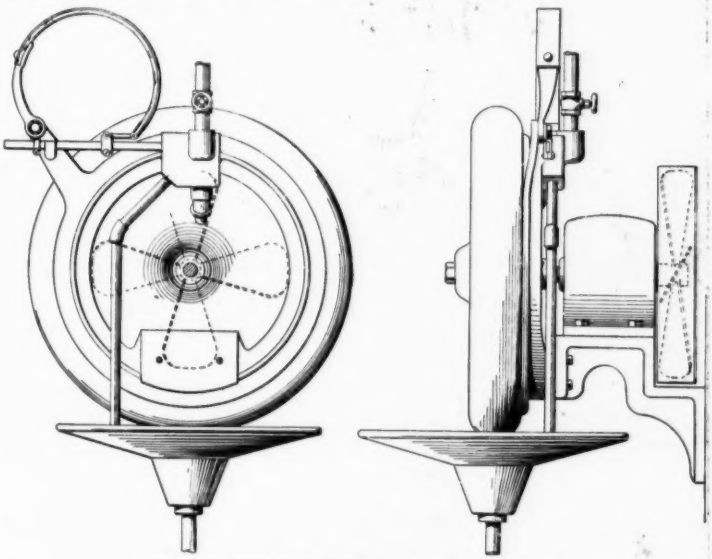
The next step in the development of humidifying apparatus produced the spray system, in which water is introduced into the at-

mosphere through some form of nozzle. Trade literature put forth by inventors and manufacturers of the older spray devices actually claimed the division of water into molecules by the mechanical effect of their marvelously efficient nozzles. This is obviously impossible; the most effective division by mechanical means can do no more than fill the air with tiny globules of water, each containing many millions of molecules. Such drops will float away in the air currents, evaporating gradually from their surfaces, until the envelope of air surrounding each drop is saturated so that evaporation ceases, or until the globule disappears. If the spray drops fall into air which is already near saturation, they cannot evaporate completely; and if they are carried into a cooler part of the room or against relatively cold objects, the process will reverse itself, and the drops will increase in size, until the fall or float into contact with machinery, fabrics, or whatever may be in their way, and form a coating of moisture.

An important detail of any spray device is the water distributor or nozzle, the effectiveness of the system being proportional to the fineness of the spray. The water is forced to the nozzles under a pressure of 60 pounds or more, and discharged in opposing streams, or against suitable obstacles, tending to divide the streams into minute drops. The humidifying unit or "head" comprises a nozzle placed in the upper center of a cylindrical casing, through which a current of air is induced by the mechanical friction of the spray. As the air from the room is drawn into and through the casing, the floating dust and lint is washed out by the spray and carried into a drip pan and thence into the drainage system. Only a portion of the water pumped to the head is carried out by the air current and evaporated. The latest type of humidifier has a divided case, hinged so that one-half can be swung aside, exposing the whole interior and making it possible to clean the case thoroughly and quickly.

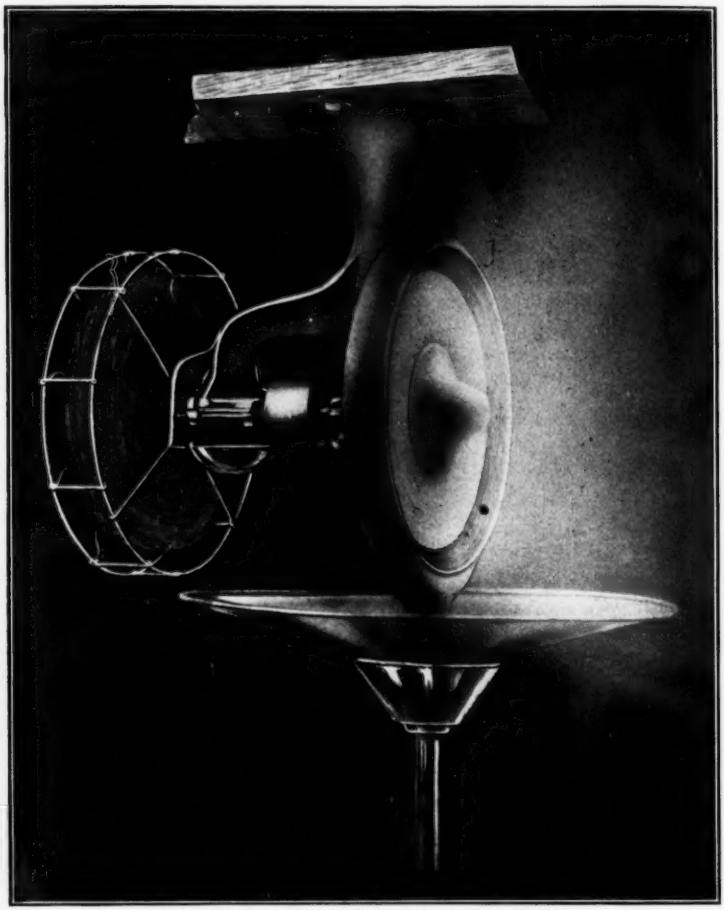
The chief fault of the simple spray humidifier is the lack of any positive means of circulating the air and floating spray. It is true that water, once vaporized, will diffuse itself rapidly (like a gas) throughout the room. This tends to equalize the variation in humidity between any two points in a room containing humidifiers spaced as in ordinary practice. As, however, evaporation is a comparatively slow process precedent to diffusion, the tendency is to produce uneven humidity, too great under and near each "head," and too little in the space between, though circulation is helped to some extent by the movements of belts and pulleys in the textile mill. Spray humidifiers have therefore been devised which provide for circulating the air

by fans, or by air blasts. Representative of the first is the Tillotson humidifier, a cylindrical casing placed horizontally, open at the ends, and supplied with a disk fan at the inlet end of the case. Water is introduced by a central sprinkler pipe, and allowed to fall upon a revolving brush, which throws the drops off centrifugally into the air current. The interior of the cylindrical wall is provided with a lining of absorbent cloth, to catch the drops which succeed in passing clear across the air current, and prevent water from running down the interior of the casing. The intention is to povide a strong current of air and to fill the current with minute drops of water which are expected to float until evaporated.



SIDE AND FRONT ELEVATION, HYGROSSO HUMIDIFIER.
Showing the automatic regulator—a cross-sawed wooden ring responding very sensitively to hygrometric changes.

Another spray system using a forced air current to distribute the drops of water during the evaporating process, is the Hygrosso, manufactured by J. W. Fries of New York. This device is essentially a disc fan, driven by belt or electric motor, and blowing against a spray-forming device placed adjacent to the fan. The current of air traveling forward from the fan, passes through the spray and carries the drops forward in a straight line. The circulation induced by this device is brisk, and extends through a considerable distance from the

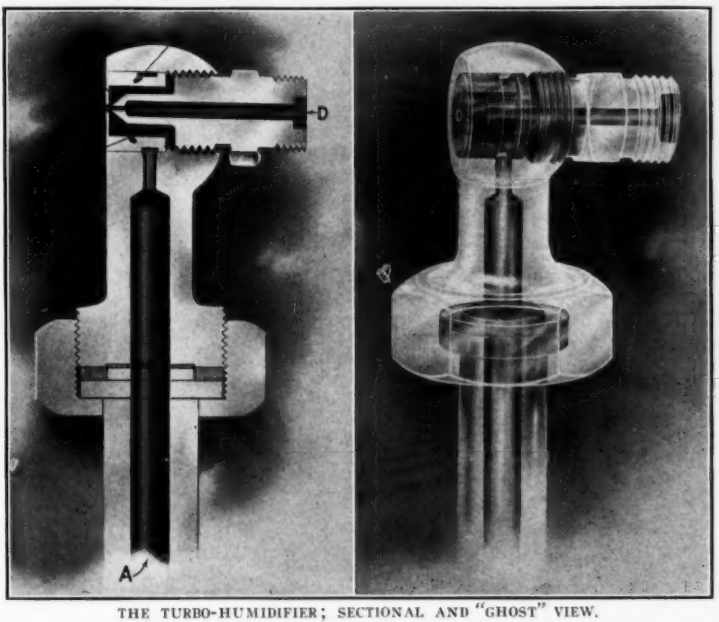


THE HYGROSSO HUMIDIFIER IN ACTION—BELT-DRIVEN TYPE.
John W. Fries, New York.

humidifier. It is a non-automatic spray, carrying forward into the air of the room all the water which is caught in the air current. The remainder is received in a pan provided for the purpose and is drained away. The forced air circulation ought to insure the evaporation of a much larger portion of the water passing through the machine than would be the case with spray humidifiers not so provided.

The system of providing circulation of spray-filled air by a direct blass of compressed air is represented by but one type, the Turbo-

Humidifier of Fitchburg, Mass. The Turbo takes its name from its nozzle, which is made with tangential ports like a turbine, through which steam or compressed air issues with a whirling motion. These jets mingle with a central stream of water, "atomizing" or spraying the latter, and forcing it out in a fine conical mist. The details of the Turbo-Humidifier are very ingenious. As the nozzles are to be placed overhead at proper intervals, any drip would fall on machines and materials below and be most objectionable. The water supply is therefore governed by a single float tank, so that the water level is an inch or more below the opening of the nozzle. The jets of air or steam act to cause enough of a vacuum to lift the water to the outlet, while any failure of the jets leaves the water to drop back to its gravity level instead of dripping on the floor below. A single tank and float controls the water supply to all the humidifying nozzles on an entire floor of the mill. The quantity of water delivered by each head is controlled by an adjustment which regulates the position of an axial water inlet, and a shut-off valve is provided with a long balanced lever with eyes at the ends, adapted to be easily opearted from the floor by a hook or stick in the hands of a workman. To pro-



THE TURBO-HUMIDIFIER; SECTIONAL AND "GHOST" VIEW.
G. M. Parks Co., Fitchburg, Mass.

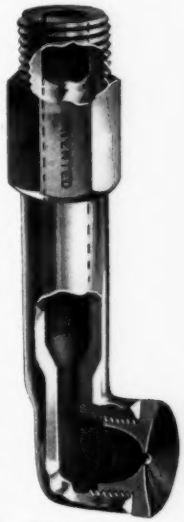
vide for ready inspection and cleaning when required, the nozzles are attached by simple union joints, so that they can be removed at a moment's notice.

With any spray system, any desired quantity of water can be put into the air of a factory or warehouse. But the only means of determining how much is desired is by careful and constant observation of the humidity by means of wet and dry bulb thermometers, and the necessary tables. The water discharged into the air must either evaporate or wet the surface of the objects in the room. It will be too much or too little according to the chance setting of the spray valves though the tendency is to maintain equilibrium so long as moisture supply, temperature, and rate of air change are constant. Only constant watching can provide even a fair approximation to uniform humidity in a large room served by spray "heads." Further, uncertain circulation of air containing floating drops of moisture may disturb the thermometer readings so that they may indicate deficient humidity, when in fact there is so much free mist that operating conditions are very bad. To provide automatically for maintaining a proper humidity, it has been attempted to regulate the operation of the system mechanically or electrically.

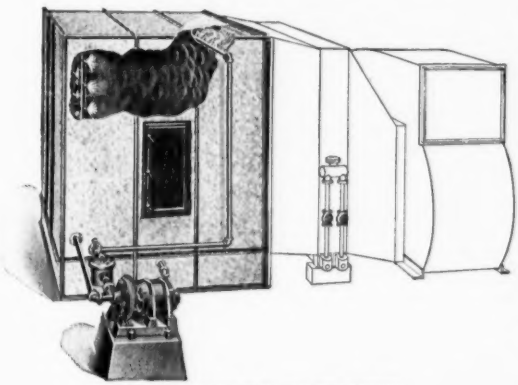
A spray system providing automatic regulation is that of Stuart M. Cramer, of Charlotte, N. C. The humidifiers of this system are of shape similar to the American, but have motor-driven fans at the top to provide positive downward circulation. Certain of the units installed in the mill are connected with the outside air, providing for an influx of air for ventilation; while the rest are spaced about the room and allowed to keep the interior air moving. The controllers depend on the principle of the wet- and dry-bulb thermometer and the fans start or stop according to the humidity of the air. The Cramer humidifier, therefore, takes note of the shortcomings of unregulated spray systems, and provides means intended to equalize conditions independently of human watchfulness.

The spray systems thus far described comprise a multiplicity of small "heads" or units, each intended to operate within a limited area. There are two systems, however, which represent the modern idea of concentration of effort in a central plant. One of these is the Osborne system of the Griscom-Spencer Company, of New York. This apparatus provides for heating and humidifying large buildings by the blower system. A slow-speed steel-plate fan draws air either from the mill, or from outdoors, or in part from each, and forces it over steam-heating pipes, and thence into a spray chamber, where it passes through a shower of water. The air next passes into a cen-

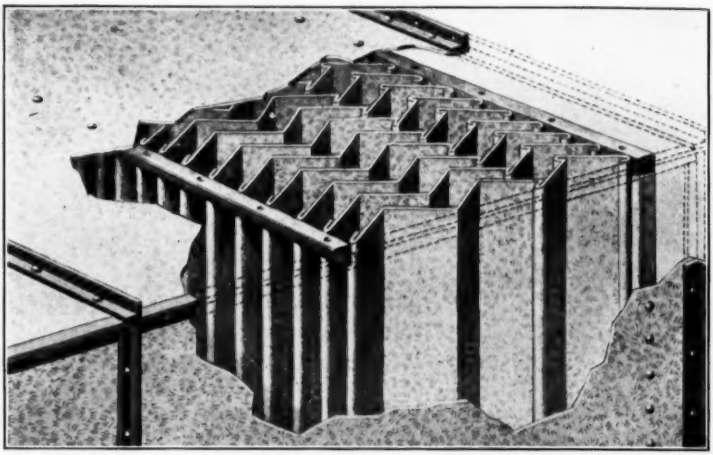
trifugal separating chamber, where the entrained drops of water are thrown out; and thence into the ventilating ducts of the mill, to be distributed through properly spaced openings. The apparatus is simple and efficient, and economical in operation. The other system is that of the Carrier Air-Conditioning Company, of New York. This apparatus is the reverse of the above, as the air is first drawn through a spray chamber where it is saturated, and then passed through the eliminator plates where all the excess water is removed, thus causing the air to leave the humidifier at the dew point or saturated temperature. The temperature of the dew point is automatically controlled by means of a thermostat which operates the dampers, controlling the air supply so that the air comes in either from outdoors or is returned from the mill, as may be required. Controlling the temperature of saturation thus fixes the number of grains of moisture carried by each cubic foot of air. The air upon leaving the humidifier is either passed through the heating coils or by-passed around them, as may be required by the mill, after which it enters the fan and is blown through the ducts into the building. The air passing through the spray chamber in summer time, on account of the latent heat of evaporation is cooled to the entering wet-bulb temperature. This means that the drop in temperature during hot weather is from 15 degrees to 18 degrees, and the air is delivered into the mill in sufficient quantities to absorb all the heat produced by the friction of the machinery, thus holding the air temperature in the mill down in summer, and at



CARRIER SPRAY NOZZLE.



CARRIER HUMIDIFIER IN OPERATION.



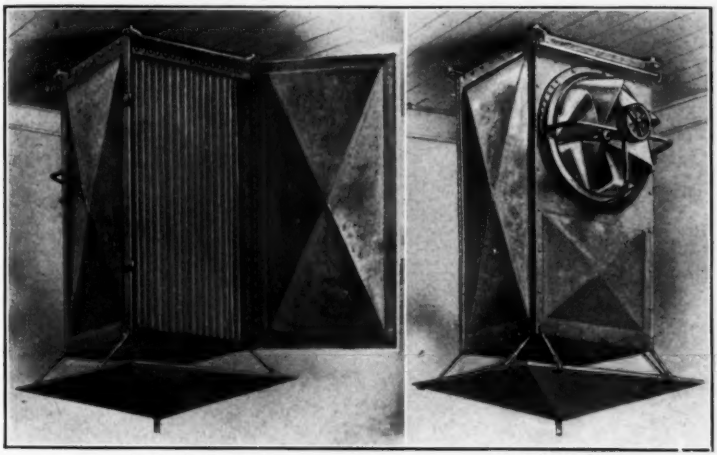
ELIMINATOR PLATES FOR REMOVING EXCESS WATER, CARRIER SYSTEM.

the same time maintaining the relative humidities desired. The Carrier system has an ingenious regulator operated on the dew-point and dry-bulb principle, maintaining a constant difference in the temperature of the saturated air leaving the humidifier and the temperatures of the room. This regulator accomplishes this result by opening or closing the dampers in the rooms, allowing more or less air, as may be required, for holding the room temperature in the proper relation to the saturated temperature, thus maintaining both a temperature and relative humidity regulation at the same time. It would thus seem that the regulation depends for its effectiveness entirely upon the difference in expansion due to the two temperatures.

As has been said, the common feature of all spray systems is the absence of any essential relation between the quantity of water thrown into the air, and the quantity of vapor required to supply the deficiency which actually exists at the moment. There is a very simple and positive natural law which provides the basis for a system in itself automatic and self-regulating—the law limiting the rate of evaporation into moist air. As previously explained, into saturated air there can be no evaporation of moisture. In dry air, evaporation from the surface of a liquid is rapid. As the relative humidity is increased by the accumulation of vapor, the rate of evaporation decreases, until at the dew point the balance is established and no more vapor can be formed. In moving air, evaporation is more rapid than in still air, but ceases at the dew point in any case. If, therefore, a suitable area of moist surface is provided, and an air current of proper velocity passed over it, the relative humidity of the air will be built up near

to the dew point, and will then cease to increase. No regulating device will be necessary, as evaporation will cease as the air becomes moist, and commence again when the air becomes dryer. This is the principle of the evaporative humidifier originally invented by Dr. Louis Bell of Boston, and also of the Benz humidifier.

The Benz apparatus consists of a chamber containing water, through which air is forced by a fan. The agitation of the water and its contact with the air current facilitates evaporation and increase of the relative humidity of the air. It is impossible to prevent the entrainment of moisture in the air current and its passage out of the humidifier in the form of floating mist. The travel of the air current in contact with the water is very short, so that it seems probable that the humidifying effect will be limited.



BELL HUMIDIFIER WITH DOOR OPEN.

BELL HUMIDIFIER, SHOWING FAN.

The Bell Humidifier, as made by the Griscom-Spencer Company, of New York, consists of a rectangular copper case containing suitable sheets of moistened cloth. Each cloth is hemmed at its upper and lower edges, the upper hem being slipped over a slotted brass pipe, and the lower end held down by a rod by which the cloth is stretched in position with sufficient tension to keep its place. The spaces between the sheets are equal, about one inch in width. A fan 18 inches in diameter, of the disc type, is secured to one side of the casing at the extreme top. By means of this fan, air from the mill room is drawn into the humidifier casing and forced down between the sheets of cloth, emerging from the bottom of the case, where it

SPINNING ROOM OF TEXTILE MILL EQUIPPED WITH BELL HUMIDIFIERS.

is deflected evenly on all sides of the machine by a drip pan a short distance below the casing. The fans of the humidifiers are driven either by independent electric motors, or by light belts, or by a group drive from a motor of suitable horse power.

Water is supplied to the humidifier (either from city mains or from a float tank under low pressure) by the small manifold pipe to which the slotted pipes supporting the cloths or mantles are connected.

Under all conditions the uniform speed of the air through the narrow spaces induces the evaporation of moisture to a maximum which depends upon the cubic feet of space supplied by each humidifier.

Objection has been made to the Bell mantles as harboring dirt and disease-germs. Impurities, however, are better out of the air than floating in it; and once in contact with wet surfaces, they are permanently retained. Bacteria, having no means of locomotion, and being millions of times larger than the molecules of water, cannot escape from wet surfaces by any process of evaporation. As the sheets are never dry, the particles cannot escape as dust; so that the elimination of floating impurities is effective and final. When the layers of collected particles become sensibly thick, the cloths may be substituted by a fresh set, and the soiled ones removed and washed and later used again.

The spray humidifier is obviously the quickest in operation, and where a possible excess of moisture is not objectionable, and great uniformity is not essential, it has the advantage. The compressed air spray has an accessory advantage in its adaptability for use with air-blast hose and nozzles for cleaning machinery. The central-plant. forced-ventilation systems do away with extensive pipe systems, and distribute properly conditioned air to all parts of the factory, with the well known advantages of such systems when used for heating purposes only. The evaporative humidifier is automatically self-regulating, tending to build up the atmospheric humidity to a constant level governed by the fixed speed of the air propelled by the fan. It has also the advantage of being independent of a central pumping plant or air-compressor, each head being self-contained, even to the extent of lifting its own water to flush its cloths, by a small auxiliary pump driven from the fan shaft.

TIME KEEPING AND LABOUR DISTRIBUTION IN THE FOUNDRY.

By Victor R. Claydon.

II. THE HANDLING OF STORES AND PREVENTION OF WASTE.

Mr. Claydon's articles are not addressed to the highly organized and amply officered foundry characteristic of a few of the latest and most advanced establishments, but to the modest plant which needs to study carefully the outlay of every dollar and the sufficiency of the returns secured. His argument is that the very practical, common-sense and simple records he advocates will much more than repay the small cost needed to put them into effect. His third article, in July, will discuss "Keeping Down Shop Expenses."—THE EDITORS.

IN all probability there is no business in which the opportunities for waste are so numerous as the foundry. The very nature of the materials used seems inseparable from waste, and for this reason many foundrymen do not even attempt to keep track of the various stores that enter into the production of castings and the maintenance of the plant. It would not be an exaggeration to say that many men are losing thousands of dollars in the course of a year through careless methods in handling this part of their business. I had a talk recently with a foundryman, in no small way of business either, and this subject was under discussion. When asked why he did not keep track of his stores, he replied that it was too much trouble, and would necessitate the employment of extra clerical hands. Moreover, he went on to say, his business was to sell his goods and make money. Here we have the point at issue, viz:—Are we making money if we do not know actually what our castings are costing us?

In order to facilitate matters I intend in this article to take the individual shops that make up the plant, and to deal with the main stores kept in each, endeavoring to show a method of handling them which I trust will be of service and will enable any manager to bring loss and leakage down to a minimum.

First of all, then, we must consider the foundry; and obviously the stores that first come to our mind are the elements that go to make up our cast—such as pig iron, coke, coal, limestone, etc. With such items as these it might reasonably be wondered whether it is possible to keep at all accurate records of the consumption. I suggest that we can do so, and in the following way: All invoices covering these materials should be handed to the stores clerk, who

will enter up on cards the amounts received from time to time. Upon the receipts of these heavy materials, it is wise I think, especially with pig iron, and if your yard space will allow, to keep this in separate car-load lots, and at the top of each pile a stick should be placed bearing the car number, as in this way we facilitate very much the taking of stock, which it is essential that we do fairly frequently.

We will now consider the use of these materials by the Foundry. At the proper time, the man in charge of the cupola charging floor is given his iron mixture, and the probable weight of the day's cast. He will now have his men bring up to the charging floor on separate trucks the different materials in the proper apportioned quantities that go to make up each charge. For example, one charge might be composed of the following:—1,000 pounds Hamilton iron; 1,000 pounds Scotch pig; 1,500 pounds foundry scrap, and 800 pounds machinery scrap, all this of course being weighed over the cupola scales. As each of these charges is put into the cupola, the man whose duty it is will enter up on a form provided for the purpose these separate weights, so that at the end of the day we have a correct record of what made up our cast. In precisely the same way he will keep track of the limestone, etc., so that with ordinary care one should obtain accurate results. This cupola report should then be turned over to the stores clerk, who will enter up on the cards before mentioned the weights of each of these different materials used; then by merely subtracting the disbursements from the receipts, we have at a glance our stock on hand, which is surely of great value to us. It prevents the possibility of running short and enables us to advise the purchasing agent as to the stock in hand and helps him in governing his receipts. Still more important, it gives us the basis for our costs, as at the end of the month we add up the different quantities used and charge them out at their price, and thus find out what our metal is costing us per 100 pounds good castings. This is a piece of information no foundryman can afford to lack.

Whilst dealing with the foundry it would be advisable perhaps to consider our foundry scrap—in other words, our sprues, gates and bad castings. Here is an item which is often very carelessly handled, this carelessness invariably resulting in one of our biggest sources of waste. It is essential that the sprues, etc., be carefully cleaned up from the foundry floor every day, and their correct weight ascertained, as obviously they return to the cupola for remelt, and the cost of our metal will in no way be correct unless our foundry is given credit for the weight and value of its scrap. An interesting

point, which was argued recently, might very well be set down here:—at what price should this remelt be charged? There is no doubt in my own mind that the following way is the fairest method of dealing with this—presuming we use two kinds of pig iron, one at $20 per ton, the other at $18 per ton, and machinery scrap at $15, the remelt should be charged at the average price of the bought materials, so that in this case it would be $17.66 per ton. Another point worthy of consideration is, should the iron, etc., be charged out at the bare invoiced price, or should freight and unloading charges be included—that is, should we take the cost of our iron, as ready to be put into the cupola? To a certain extent this must be governed by the cost system in force, but I think it is wiser to charge these at their value to us ready for use, otherwise freight and unloading charges must go through the foundry burden, in my opinion unnecessarily swelling it. It is always the better plan to keep our burdens as low as possible.

We will now consider our moulding and core-shop supplies; the principal of which is, of course, sand—perhaps one of the most difficult things to keep track of at all accurately. A system similar to the following is about the best I know of. In convenient proximity to our sand piles, pads should be nailed up and every time an employee brings out a wheelbarrow load he should make a mark on the pad. At the end of the day the sheets with these marks on should be turned in to the foundry clerk, who would know the approximate weight of a barrow load and by totalling up the number of marks made would be able to record on his report the daily quantity of the sand used in the several shops. Facings and oil, etc., may be treated in much the same way, and when these various reports reach the stores clerk he should deal with them as explained previously. In addition to the items mentioned there are of course the small stores used in the foundry and core shops which I will deal with later on in this paper.

From here we pass along to the machine shop, and here perhaps we have the greatest difficulty on account of the numerous stores that have to be kept in connection with it. In all probability in conjunction with our machine shop we have our blacksmith's department, and obviously there is our wrought iron to be dealt with. It may not always be possible, but where it can be done this iron should be kept in racks according to the different sizes, each rack being labeled according to the size contained therein. The blacksmith on using any of this iron would of course enter up the quantity used on his time card, at the same time giving the nature of

the job on which the iron was used. In this way our stores clerk can enter up periodically (daily if necessary) the quantities used in this department. In the machine shop generally most of our small stores are used, such as nuts, bolts, etc. These should be under the control of a general storekeeper, and such goods issued only on a requisition being sent in to him by the foreman of the shop requiring them. Such requisitions should state also on what work they are to be used, as only in this way can we apportion our material burdens to their proper shops and location. It should also be distinctly understood that nothing can be given out by this storekeeper except on the duly authorised form; it is only by the strict enforcement of this rule that we can ever hope to keep or receive accurate records. In the article that appeared in last month's issue I hinted at the possibility of our metal pattern department becoming our graveyard with regard to the time expended on patterns; so in the same way it will be with the stores used here, unless strict surveillance is kept on everything. Obviously steel forms an important part in this shop. This can be dealt with in much the same way as our wrought iron in the blacksmith's shop, but as this is a far more expensive item I would advocate at least our high-speed steel being kept under lock and key, and issued only in such lengths as are required for the particular job on which it is to be used.

Passing from the machine shop we come to our wood pattern department, and here we are confronted with the lumber used therein. Much the same methods prevail here as with our iron and steel, but we must not fail to take into consideration the fact that an enormous amount of waste occurs here, as for example in odd lengths of lumber, left over from jobs, which are of no avail for others; therefor the important thing to remember is that when taking lumber to be used on a job we must charge out the quantity actually taken, otherwise we shall be the losers; the reason is self-explanatory.

Before proceeding to the clerical end of the stores we must take a glance into our general stores. Here we have those hundred and one different articles, insignificant in themselves, perhaps, yet which if not properly looked after may cause a considerable loss of money. It may happen—nay, it has happened—that a man will go to the storekeeper for a box of screws without an order, and the storekeeper lets him have them, thinking that it was only a matter of a few cents; yet if he does this with one he will do it with another, and his laxity will mean inaccuracy in our costs. There is an old proverb which might well be applied in this connection "Take care of the pence and the pounds will take care of themselves." Let our

storekeeper then see that nothing goes out except on a written authorisation, and our chance of waste will surely be minimised.

Having so far dealt with the arrangement and handling of the stores through the various shops, our next step must be to see their use in the office. We are often confronted with the remark that costing involves too much of the proverbial "red tape" or "paper work" and I am inclined to think that in some senses of the words this is only too true. One will often see an elaborate system carried on as far as the office end is concerned, while the departmental part of the work (which is probably even more important) is left pretty much to itself. In short, as long as the office receives a monthly record of the materials used in the shops everything is O. K., no trouble being taken to verify the statements so sent in. Surely this is "putting the cart before the horse." Undoubtedly, the correct method of handling our stores in the shops should be our primary consideration. Unless this is done the result is self-evident, viz., the official returns are not worth the paper they are written on, and our costs are absolutely no good to us; in fact, they are more harmful than otherwise. In too many of our foundries this fact is only too plainly manifested. Efficient stores management is one of the keynotes of good business. Provided, then, that we can rely upon our records, (and I am sure there is no reason why we should not) we have something that is indeed worth while for our trouble.

In dealing with the office end of the work then let us first think of our invoices. After these have all been O. K.'d by the purchasing agent, the stores clerk will enter them up under the separate articles designated in his stock material ledger, taking care (as in the case of pig iron and suchlike materials) to see that the freight and unloading charges are added to the invoice cost. After all the requisitions on the storekeeper and reports from the different shops for materials used for the month are in, he will proceed to credit his stores with the various items, at the same time charging them out again (in the distribution columns provided in his ledger) to the various accounts to which they are chargeable, as designated on the requisition forms.

Dealing with your receipts and disbursements in this way serves a twofold purpose. First, it serves as a perpetual inventory of goods on hand, as at the end of the month this ledger should be balanced and the totals brought forward to the next month. If this idea is properly carried out we have a reliable inventory. This in itself is of undoubted value, as in the case of fire destroying our works we can ascertain from these records the value of our stock on hand.

Second, by charging the stores out to the specific jobs on which they were used, the clerk can at the same time make out his shop-material burden reports (much in the same manner as the pay-roll burden form shown in my previous paper) and thus find out exactly what each shop has cost for stores used in manufacture and shop expenses. The value of this information is surely incalculable, as it shows up at a glance any undue expenditure on the part of any one or all of the shops; also, it enables the employer to find out the cause of the outlay and to know the why and wherefor for every charge made, thus preventing a repetition. Again, when a foreman is made to understand that his shop is going to be charged with everything used in it, he is naturally on his guard to see that his men waste nothing and that proper charges are made on all his requisitions; so that one can almost be certain that any orders issued will only be those that are absolutely necessary. You may depend upon it, no foreman wants his employer to come to him at the end of a month and tell him that his department is costing more than it should; and I believe that if this were done the foreman themselves would appreciate the knowledge to find out some way of further lowering their expenses, but this I hope to take up in a subsequent paper.

There is one other benefit derived from a systematic handling of our stores which must not escape notice. It is, I think, a recognised fact that in every establishment of any magnitude a considerable amount of pilfering goes on which it takes all one's time to detect, let alone put a stop to; but I suggest that under the system here outlined, where a man has to have a written order for everything signed by his foreman, the chances of his getting something for himself are reduced to a minimum, if not entirely done away with.

It may appear that taken individually the advantages accruing from such a method of handling our stores are not very great; but, when taken together, at least they certainly prevent waste,—which, as I have already mentioned, is only too often at the root of our high cost of production—and as our aim in view of keen competition is to get our costs as low as possible, it behooves us to see that we use every legitimate means at our disposal to secure this result, bearing in mind the fact that the clerical work required for the carrying out of this work is repaid over and over again by the prevention of such a great leakage as will exist when a careless method of handling our stores is persisted in.

The next article will consider practical means for "Keeping Shop Expenses down."

EDITORIAL COMMENT

The Principles of Efficiency.

HARRINGTON EMERSON'S earlier articles, which were published in THE ENGINEERING MAGAZINE July, 1908, to March, 1909, and afterwards issued in book form, were essentially the statement of a philosophy—a philosophy so fine and so hopeful as to merit the designation we then gave it of a gospel.

The studies begun in this issue, even stronger in demonstration and more specific in statement, are a reduction of ideals to practice. Mr. Emerson has formulated the requirements of any achievement as being: first, imagination—the single and definite idea of something to be done; second, principles, several or many, by which the doing must be guided; third, methods, still more numerous, for the expression of each principle; fourth, devices, which may be innumerable for the execution of any method. Methods and devices are usually standard. Imaginations are inspired. Principles are derived from correct interpretation of the laws of the universe. The series begun this month performs the invaluable service of defining the principles by which the great concept of Efficiency is realized.

In the introductory article leading this number, Mr. Emerson shows the successful working of these principles in historic examples. The next part will take up the organization necessary for their application in industrial undertakings. Following numbers will define and discuss the twelve principles separately and successively.

The appearance of such a teaching is peculiarly opportune, for the toll laid upon the nation by extravagance and waste due to inefficiency is growing too heavy to be borne, and the resistance to it is causing a great awakening of inquiry and effort toward relief. The vicious cycle so strikingly described by Mr. Gantt in the opening paragraphs of his article in this number has been too often repeated. We have gone too far in devoting our keenest thought, our best talent, our largest energy, our shrewdest personnel, to making and raising prices—to marketing our wastes with our product, our chaff with our wheat. With striking identity of vision, two great industrial philosophers—Emerson and Gantt—announce like conclusions. With individual differences of method they apply similar principles. And this issue of THE ENGINEERING MAGAZINE which presents Gantt's valedictory with regret that it *is* a valedictory, welcomes Emerson's salutatory in another preachment of the great promise of efficiency.

Insurance of Workmen.

IN a problem like that of insuring workmen against accidents or injuries incident to their occupation, there are so many forces and influences at play that theoretical deductions must yield to experimental results. Whether employers would be less careful to surround their men with safeguards when all accidents were paid for from a general fund; whether men would be more careless when they knew loss of life or limb would bring prompt compensation to themselves or their next of kin—these points are conjectural and controversial. The total result of ten years' experience in Germany is substantial fact. One such well-tested demonstration is better than many predictions and much argument; and for this reason Mr. Dawson's earnest advocacy of the German system of employers'-liability insurance (reviewed on page 411 of this issue) comes into court with its case more than half proven.

It is clearly to be read in the signs of the times that something directed to similar results will be attempted before long by American legislatures. The whole trend of economic thought and regulation points that way. The wise policy for manufacturers is to lead public opinion to the best solution—not to be forced to accept any measures wherewith excited sentiment might override their resistance.

Insurance, of course, is simply a means for spreading loss over so broad a foundation that it can be borne without sensible distress. The companies do not pay the losses; they are merely vehicles whereby the contributions of the real loss payers (the men untouched by death or fire or accident) are passed over to the losers, at more or less expense for administration and with more or less profit to the agents who manage the business. Incidentally, the so-called "insurers"—the real intermediaries—scrutinize every risk, study intelligently the causes of loss, and by reduction of preventable waste among the many, do even more good than by reimbursement of the occasional sufferer.

Thus, everywhere, insurance is found a beneficent institution, not only mitigating individual misfortune, but effecting a great total saving in the world of finance, commerce and industry—saving, further, the social organization from the demoralizing shocks of isolated individual disaster. If we do not see the advantage and the necessity for a similar protection of the exposed human units of our great productive army, it is simply because our eyes are yet darkened. But the loss of the thousands and tens of thousands maimed and killed in our mines, in our manufacturing plants, our railways, falls on the nation—every penny of it, with interest and multiplied by the inefficiency of our ill-ordered and unfit measures for meeting it. Well-devised labor insurance systems would be the replacement of the ways of barbarism by an effective civilized institution.

Concerning Technical Education.

A VERY interesting editorial in the *Scientific American* of May 7, entitled "The Decline of the University in Scientific Research," points out that the establishment of amply endowed special institutions offers to scientific men of a certain type, in enlarged measure and in more attractive form, the sort of opportunity formerly found only in the professor's chair. As a result, the colleges of the United States are losing, and to an increasing degree are likely to lose, the type of men who heretofore have given them much of their professional standing.

The writer of the editorial understates, if anything, the difficulties imposed upon university work by the growth in size and in number of students, which, unfortunately, is generally regarded as desirable by college authorities today—unfortunately, that is, so long as it is not accompanied by equivalent evolution of methods. It is impossible for the professor to maintain the personal contact with his students that, with smaller classes and with great teachers, made a college education in the best sense. Mark Hopkins on one end of the log was a vital force; but when the log becomes the trunk of a giant redwood, crowded to its farthest end with thronging students, the radius of even Mark Hopkins' influence is too short.

It is asking too much in proportion to the reward when we require in our university teachers a combination of high scientific attainments, strong personality, influential character, diplomatic tact, pedagogic skill, expertness in organization, high administrative ability, enormous endurance of hard work, and tolerance of the exactions of vast and intricate detail. The minor functions

and the bounds and burdens of organization are perhaps most irksome to the largest minds.

The inevitable result is the retirement of many men the university should most desire to retain. The endowed laboratory appeals to some. The great corporations (which already are supplementing the college training of their junior personnel, and in some cases are on the point of supplanting it by institutions of their own) are absorbing and in increasing degree may absorb others.

That college and university education —especially in applied science—is reaching a critical point, is perhaps more apparent to those whose contact with it is external than to those whose contact is internal. By a critical point is not meant a peril to existence or continuity, but the more limited signification of a change in direction or character. What this change should be is worthy the most earnest study of the greatest educators. Generally it would seem that it must be akin to that which is so imperatively necessary in our utilitarian activities, in agriculture and industry: that is, it should be toward *intensive* and away from *extensive* effort. It should tend toward greater differentiation of duties, toward introduction and development of that functional type of organization referred to by Harrington Emerson in the leading article in this issue. To an increasing extent, probably, the university must enlist the co-operation of the specialist in active professional practice; but to secure his co-operation, it must be made more possible than it is now for him to work freely and efficiently. The problem is one of efficiency; and unfortunately, the highest governing bodies of our universities, upon whose decisions and acts the rapidity of this evolution in efficiency must depend, are drawn chiefly from professions or occupations in which the principles of efficiency are least understood and least recognized—the church, the law, and finance.

An Incident of Naval Reorganization.

THE exit of Paymaster-General Rogers is a painful but plainly necessary incident in the effective reorganization of the United States Navy, which Secretary Meyer is carrying out. A department so closely concerned with the efficiency records the plan purposes to secure must be especially administered in harmony with it, or the discordant factor must be eliminated. It should be remembered that the Pay Department claims the authorship of the cost system in force. In view of the curiously obsolete methods now alleged to be employed for the principal records, it would seem that sorrow over the retirement of an earnest and active official might be tempered by hope that, without introducing any of the intricacies in which some professional accountants delight, a more illuminating practice might be introduced.

It is unfortunate, as pointed out elsewhere in these pages, that when new principles are presented, some men, used to the older order, make a personal issue of the matter—as if a good, honest calculator, versed only in multiplication and division, should regard a table of logarithms as an attack on his character.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

LABOR INSURANCE IN THE UNITED STATES.

A DISCUSSION OF THE UNSATISFACTORY FEATURES OF EMPLOYERS' LIABILITY INSURANCE IN THE UNITED STATES AND POSSIBLE MEANS OF IMPROVEMENT.

Miles M. Dawson—National Metal Trades Association.

THE discussion of employers' liability insurance before the National Metal Trades Association at the recent convention in New York is only one of many indications that the establishment of a rational basis for workmen's compensation for accidents is at last receiving general recognition as one of the most important industrial problems of the United States. In four States—New York, Minnesota, Illinois and Wisconsin—the problem is being studied by legislative commissions, all of whom have under consideration the German system of labor insurance. During the month of April voluntary plans providing for liberal compensation for accidents were announced by two large corporations, the United States Steel Corporation and the International Harvester Company. The acceptance of the problem by an association of employers of national scope, however, is highly significant, and the interest manifested in the plan for the establishment of a mutual insurance fund proposed by Miles M. Dawson to the National Metal Trades Association is a strong encouragement to the hope that a long-standing reproach on American industrial methods will soon be removed. We quote at length from Mr. Dawson's paper.

"As at present supplied in the United States, employers' liability insurance consists of an insurance company undertaking for a consideration, called a premium, to assume the liability of the employer to his employees who are injured by reason of what the law terms negligence, and to the next of kin of employees who lose their lives through his negligence. In practice it consists in the insurance company making it a business to drive as hard a bargain as it can in the settlement of claims of this nature or to resist such demands and defend against them in the courts if necessary, according as one course or the other may seem less expensive or for any other good business reason more desirable.

"This system has not proved satisfactory to any of the parties in interest. It is not satisfactory to employers, because, while it appeals to them as a ready means of escaping annoyance and occasional excessive verdicts, it involves the payment of large amounts which go for agency, adjustment, home office and other expenses, and which must be paid by the employers in addition to the sums that actually reach the injured employees and the next of kin of employees who are killed. It is unsatisfactory to the companies because they find that there is constant pressure upon them to be more liberal in their settlements since the employer is not directly affected by each settlement, and at the same time equally constant pressure upon them to furnish the insurance at lower premiums. They also tire of being continually in the courts or continually resisting the payment of claims, and competition among them is resulting in several of the com-

panies choosing to make prompt settlement in as many instances as they can, instead of standing upon their rights under their contracts and under the liability law. It is not satisfactory to the workmen and their next of kin because they are confronted with a purely business proposition at a time when there may be very great need, and when, under the old conditions, the employer might, and very likely would, as a matter of sympathy, contribute to their relief, even though not liable under the strict letter of the law. Another objection on their part is that litigation is more expensive to them, longer drawn out, more bitterly fought and the defense conducted by men of special skill in such matters. They also urge that often advantage is taken of their necessities to drive a specially hard bargain without their being made aware of their rights in the matter.

"There is also a fourth party to the transaction—the public. Whatever employers or employees fail to do for the relief of the victims of industry falls upon the public in the most unfortunate form of charity or even, eventually, by reason of the impoverishment of families and the consequent failure to educate and train children, through courts and prisons.

"The superior efficiency of German workmen, on the whole, is very largely ascribed by everybody to the system of employers' liability insurance which has been introduced in Germany.* The general impression in the United States is that Germany has a system of State insurance, where the State collects premiums from the employers, administers the funds, pays the claims and in general manages the whole affair. The fact is precisely the contrary. The system is one under which the trades themselves are organized into mutual trade associations such as your own, to which every person or company engaged in that trade is by law required to belong and which are managed by their own members. The liability to employees is transferred from the individual employer to these trade associations, and the amount of liability is absolutely fixed by law and is likewise entirely independent of questions of negligence, so that there is no quarrel over whether the employer is liable or not. The only difference of opinion that arises is when there is partial disability, the degree of which has to be determined. While these associations are conducted at an expense of about 10 or 12 per cent., it is generally conceded that their effectiveness, both in the shrewd and careful management of their business and also in bringing about the adoption of safety devices and a reduction in the hazards of industry, far exceeds that of any system which has been introduced in any other country.

"Under the German system the amount of liability in event of total disablement is fixed at a certain proportion of the wages and is payable like wages—that is, by weekly payments. In the event of partial disability an amount proportionate to the impairment of the earning power is paid. In the event of death a pension is paid to the widow during her widowhood—that is, until her death or remarriage—and a pension to each child until he reaches 16 years. These pensions in the aggregate must not exceed the amount that the man would have received himself had he been totally disabled. This system I personally regard as the most satisfactory one for employers' liability insurance that can be found in any country. It could be introduced here, precisely as it is in Germany, only by means of legislation. If there were such legislation, as our national Constitution now stands, it would apply only to individual States and would take effect in those States only when adopted by their respective legislatures."

Besides the usual form of employers' liability insurance, four methods of voluntary insurance are available to individual employers or to trade associations of employers under the laws existing in the United States. One of these is the workmen's collective policy, issued by a liability insurance company for protection of workmen, without regard to liability, the employer's contribution toward the premium entitling him

* A complete description of the German system was published in THE ENGINEERING MAGAZINE for July, 1907.

to be protected against liability either under the terms of the collective policy or by another policy at a reduced rate. A more recent form of insurance is the "employer's compensation policy," under which the employer is authorized to compensate his employees for injuries sustained, without regard to liability, on the basis of the wages earned at the time of injury, the insurance company undertaking to defend the employer in the event of a suit, in other words, to protect him against liability. The third method is a system of insurance, paid for by monthly premiums and furnishing sick benefits as well as accident benefits, the employees either contributing the whole or the employer making such contributions as he may desire, no arrangement being made to relieve the employer from liability. The fourth method is by a mutual insurance fund created by and among the employees and supported by their contributions, either assisted by contributions on the part of the employer or entirely independent of such contributions. When the employer contributes, it is common for him to have either an agreement in advance that he shall not be held liable under the law, or else that a receipt and release to that effect must be given before any portion of the benefits provided by the fund can be drawn.

"It cannot be said that any of these systems is, except in rare cases, at all to be compared with the system in use in Germany. The difficulty with each of the first three is that the benefits are not large for the contributions made. Relatively large expenses are unavoidable. There must be solicitation by agents, usually not only of the employers but also of the employees. There must be collection expenses to be paid by commissions or otherwise; there must be adjustment from some central office—with the sole exception of the new 'employers' compensation policy,' which provides for direct settlement of claims—and there must be litigation which is costly on both sides. None of these three approaches the fourth, or mutual, method either in economy or in avoiding litigation. Under mutual schemes to which employees contribute, and especially if employers also contribute, there is usually a reasonably complete provision made for the maintenance of the disabled employee and his family; and, since this provision is immediately available there is usually no question raised as to accepting it and going forward without calling in the lawyers or the courts. The expenses should rarely, if ever, exceed 10 per cent. of the amount paid out in benefits; whereas it is not probable that any of the others can be operated at an expense of less than from one-third to one-half of the total amount paid—in other words, from 50 cents to $1 for each dollar of benefit." In Germany a system of this character in operation at the Krupp works is considered more beneficial and more satisfactory than even the perfected plans introduced by the Government.

"There would be obvious advantages if the members of the Metal Trades Association could and would combine to cover their liability and to provide for their injured workmen and the families of workmen who are killed through their mutual trades association or a subsidiary association connected with it; and if this were established upon a sound insurance and actuarial basis, unquestionably a larger measure of relief to the injured and the families of the dead could be given without an increase in expenditure. Indeed, the benefit would be increased nearly, if not quite, 50 per cent. as compared with the cost of employers' liability insurance. Yet these benefits could be paid without an increase of cost to the manufacturers, by permitting and encouraging or, best of all, requiring employees to contribute in order both that larger benefits might be paid, and also that all sicknesses and disabilities might be covered without regard to negligence, and also without regard to whether they are incurred while the workmen are at work or when they are off the work.

"There is nothing Utopian or altruistic in such a proposition. It has been thoroughly proved to be a businesslike thing to do, resulting in great economies directly and indirectly, and also in creating a body of unusually efficient, reliable and steady workmen."

THE PROTECTION OF PILES IN SEA WATER.

A REVIEW OF METHODS OF APPLYING CONCRETE SHIELDS TO SUBMARINE PILING ON THE PACIFIC COAST.

Ralph Barker—National Association of Cement Users.

IN a recent number of this magazine, General W. A. Jones has described the devastation wrought by marine borers on wooden submarine structures, and has given an outline of the methods of protecting piling commonly employed. Marine borers, particularly the *teredo*, infest the waters of the Pacific Coast in enormous numbers. So destructive are they that in as short a time as eight months the bearing capacity of untreated fir piles is practically destroyed, and it is absolutely out of the question to use untreated timber in water in which the *teredo* occurs, except for extremely temporary work. On account of the cheapness of the method, impregnation of piles with creosote or some other chemical distasteful to the borers has been widely employed on the Pacific Coast, but, as General Jones has pointed out, this method of protection has been only an indifferent success. It is being rapidly superseded by the application to piles of a surface layer of some material impervious to the attack of the borers, and as concrete is the cheapest, most readily available and most easily applied material, a rapid extension of its use for this purpose may be expected.

Ralph Barker has given, in a recent paper before the National Association of Cement Users, reprinted in *The Engineering Record* for March 26, a summary of three methods of applying concrete to the protection of submarine piling employed in San Francisco harbor. Two of the methods are applicable only to new structures before the superstructure is in place, while the third may be applied to the piles at any time.

"Since the *teredo* works from the mud line to low water," says Mr. Barker, "and the *limnoria* from low water to high water, it is necessary in order to insure immunity to protect timber from the mud line to high water mark. As the mud line is a somewhat varying factor, it is very desirable to extend the covering to a sufficient depth to preclude the possibility of the unprotected portion of the timber becoming exposed.

"The first method employed in San Francisco harbor covers the use of a metal or wooden cylinder around the pile and filling same with concrete. This method was first introduced in 1894. Steel cylinders 3½ feet in diameter were used around a cluster of three piles. First the piles were driven in the proper locations, then the mud was removed from inside the cylinder to a depth specified. This depth was governed by conditions, and was usually about 30 feet below low water. Then concrete sewn up in loose-mesh burlap sacks was placed in the cylinder in sufficient quantity to fill it nearly to low water line. This was allowed to set and the water was then pumped out and the balance of the cylinder filled with loose concrete. This method was later cheapened by the substitution of wooden stave cylinders for the steel.

"The most recent practice in this method is to use, instead of a 3½-foot cylinder, one only 2 feet in diameter, having a cast-iron shoe in its bottom which fits as close as possible around a single pile. Rope grummets are placed around the pile, and as the cylinder is driven the grummet is forced tightly between the casting and the pile, thus making a tight joint, which excludes the mud and water to a very great extent. What mud and water may have gotten inside the cylinder is then removed by a jet pump and the cylinder is filled with concrete, same being reinforced with vertical rods held in place by horizontal bands. The latter practice gives the best results, as the placing of concrete under water, even in sacks, is almost certain to cause a separation of the ingredients. The wooden cylinder is eaten away by the marine insects in a short time, and if the concrete is not perfectly sound the *teredo* enters through the voids in the shield and destroys the piles.

"The second method consists of using a concrete cylinder of about 24 inches external diameter and 2¾ inches thick, heavily reinforced. The length of the cylinder is governed by conditions the same as the wooden cylinder above described, the longest used being 34 feet. The cylinder is driven around the pile, pumped out, and filled with concrete in practically the same manner as when the small wooden cylinders are used. This method gives very good results, as the outer shell is made on the surface, where it can be examined and rejected if defects appear.

"The third method differs essentially from the foregoing, and can be applied to an old structure without removing the top work. It consists of the use of a sheet metal form having a diameter of about 8 inches greater than the pile to be treated, same being placed around the pile in short lengths. The bottom of the first form applied to the pile is equipped with a diaphragm, which fits closely around the pile and accommodates itself to its decreasing size. The form is placed around the pile and has attached to it two wire ropes from a windlass on the floor of the structure. Then a cylinder of reinforcing material is placed inside the form and it is filled with concrete. This section is then lowered into the water sufficiently to allow the next section to be constructed around the pile and fastened to the one already filled. The process is continued until the first section comes to rest on the bottom of the bay. In ordinary mud the weight of the column of concrete will force it down into the bottom a sufficient distance to insure protection.

"All three of these methods give very good results. The last mentioned is the cheapest, but when it is used the pile it protects must extend up to and support the superstructure. In the other two methods the pile may be cut off at low water line, and the balance of the support made a reinforced pillar, getting its lateral strength from the reinforcing bars, which may be made continuous for the full length of the concrete casing.

"As to the type of hydraulic cement best fitted to secure the essential quality of enduring strength when used in sea water, the subject has been, and still is, one of considerable question. The two destructive influences commonly believed to be most necessary to provide against are: (1) The peculiar chemical disintegrating action of the magnesium sulphate content of ocean water upon the aluminium compounds in the cement. (2) The physical wear of the surface of concrete thus chemically affected and softened by the abrasive action of the water, and the greater or less content of sand which it may carry with it."

A cement known as "erz-cement," or "iron-ore cement," in which the aluminium is largely replaced by iron, in order that the chemical action of sea water may be reduced to a minimum, has been placed upon the market in Germany. Reports of tests seem to indicate that iron-ore cement will withstand chemical action much more successfully than Portland cement of the ordinary character. Puzzolan-Portland cement is another material of German manufacture which is practically unattacked by sea water, but as neither Puzzolan-Portland nor iron-ore cement is produced in the United States, the American engineer has been confined in sea-water concrete construction to the use of Portland cement.

"Although disastrous disintegration has occurred in some instances, it is nevertheless true that the great mass of well constructed Portland-cement concrete in sea water has served its purpose satisfactorily. Portland-cement concrete has the power of armoring itself against the action of the magnesium sulphates of the sea water by the formation on its exposed surfaces of a skin or film of lime carbonate. In comparatively still waters this appears to constitute a very effective protection. In case of violent or continued abrasion of water and sand it is naturally less effective, and in exceptional cases has no opportunity to form. In these cases the calcium hydrate set free by the decomposition incident to the hardening of the Portland cement is washed away, leaving voids for the further inroads of the deleterious chemicals contained in these sea waters.

"In selecting a Portland cement for marine construction, the ordinary precautions taken to secure a trustworthy

material, that is, careful and accurate sampling and testing, are absolutely essential. That the cement must be sound goes without saying. Since only the very finest portion, the 'float,' of the Portland has cementious value, fine pulverization is essential, and a matter of much economical moment. Too slow a setting is to be avoided, and a rapid permanent hardening is of value. These, however, it is unwise to secure by the use of cements high in aluminium, since it is the aluminium content that is most vulnerable to chemical attack."

THE PHASE ADVANCER, A NEW ELECTRICAL DEVICE.

A NEW SOLUTION OF THE PROBLEM OF IMPROVING THE POWER FACTOR OF INDUCTION MOTORS.

The Electrician.

THE troubles caused by wattless currents are familiar to all engineers responsible for the operation of plants on alternating-current systems where the power factor is low. While these currents load up the generators and mains, they have a demagnetizing effect upon the generator field magnets, calling for increased power for excitation and rendering it difficult to maintain the pressure. In some cases they prevent the full output being taken from the prime movers, thus destroying the possibility of making most economical use of the generating plant. A principal cause of low power factor is the presence of induction motors on the system, and owing to the growth of power loads, the question has arisen whether it is possible to provide at the motor itself a means of compensating for these lagging currents.

A solution of this problem is offered in the "phase advancer," devised by Miles Walker and already described by him in a paper read before the Institution of Electrical Engineers. The device may be briefly described as a special form of exciter connected in circuit with the rotor winding of the induction motor, to which it supplies magnetizing current generated at low voltage and low frequency, the frequency of the slip. Taking a slip-ring induction motor having a power factor of about 92 per cent. on full load, it is possible by means of the phase advancer to arrange that instead of a lagging current the motor may run at unity power factor, or even be caused to take a leading current up to 30 to 40 per cent. power factor, so as to compensate for lagging current taken by other motors, etc., in the system. The development of the machine has now reached a commercial stage, and a unit recently built to be used in conjunction with a 900 kilowatt induction motor has yielded satisfactory results. For a technical description of the construction of the phase advancer we may refer our readers to Mr. Walker's paper, which was read early last year. Our present concern is with the practical possibilities of the invention, which are summarized in *The Electrician* for April 8.

"When the phase advancer is used in connection with an induction motor, the amount of idle power required for magnetising is only a small fraction of that required when the magnetising current is supplied at full frequency and full voltage in the stator winding. This will be appreciated when it is considered that a 750 brake horse-power, three-phase, 50-cycle, 2,000-volt, 590 revolutions per minute motor requires in the stator winding 50 amperes per phase as magnetising current, or an idle power of 175 kilovolt-amperes. When fitted with a 6 kilovolt-ampere phase advancer the same motor will run at unity power factor and require no idle power from the mains. If the same motor were fitted with a 12 kilovolt-ampere phase advancer it could be run at a leading power factor of 0.7, when, in addition to its ordinary load, it could also compensate for the lagging currents produced by other motors to the extent of its full kilowatt rating of 600.

"Again, by building a similar motor, but with a larger percentage of copper in its windings, it would be capable of supplying magnetising current to three motors of the same size, when a total

power of 3,000 brake horse power would be obtained with the line working on unity power factor, the only cost being the 12 kilovolt-ampere phase advancer and additional copper in one motor. In such an installation, with motors having a power factor as high as 92 per cent. and a voltage drop in the line of 10 per cent. without phase advancers, by the use of the latter a saving in the line losses amounting to about 40 kilowatts could be obtained. Further, a generator specially designed to take a load at unity power factor would be smaller and cheaper, and would have all day losses reduced by about 30 kilowatts. This would give a total saving in generation and transmission of 70 kilowatts, against which must be set losses in the phase advancer and in the winding of the over-compensated rotor, amounting, however, to not more than 6 kilowatts.

"The above case relates to high-speed motors having a good power factor. If, however, we consider slow-speed motors which would have a power factor as low as, say, 0.7, the saving in the line and generators would be not less than 220 kilowatts. In this case two phase advancers would be used, two motors being over-compensated to provide the wattless current taken by the other two, and accordingly in this case the losses in the exciting circuit would amount to about 18 kilowatts.

"An important consideration in connection with the use of the phase advancer is the following: Suppose a large motor with a low power factor at the end of a long feeder; by installing a phase advancer in conjunction with the motor the feeder would be relieved of wattless current, and thus part of its copper set free. Accordingly, new consumers might be connected to the feeder at the end adjacent to the motor, and the revenue obtained from the cable correspondingly increased.

"Another use for the phase advancer is in conjunction with induction motors under conditions where a large slip is required, such as for winding purposes or for driving rolling mills. This slip is at present obtained by inserting resistance in the rotor circuit, which means a large loss of energy. By means of the phase advancer the slip required may be obtained and the power returned to the line, instead of being wasted.

"A further advantageous use for the phase advancer is in connection with induction generators. Such machines have the important advantage over the ordinary alternating-current generator with continuous-current excitation that they may be run up to speed and switched on to the 'bus bars without synchronising. This class of generator has not been very much employed even in cases where it appears to present certain advantages because the ordinary induction generator required to be supplied with magnetising current from the line, and, furthermore, it is incapable of generating any wattless current to supply to induction motors or other apparatus requiring wattless or laging currents. If an ordinary induction generator is connected to a distribution system in parallel with synchronous generators, the synchronous generators have to supply not only the wattless currents required by their share of the load and the wattless currents required by the rest of the load, the true watt part of which is carried by the induction generators, but they are also called upon to supply further wattless currents to magnetise the induction generators. So that instead of being a help in that part of the load which is most trying to every generator, the induction generator is actually a further drag on the system. By means of the phase advancer this drawback of the induction generator is overcome, and it is possible to build an asynchronous generator which not only supplies its own magnetising current but is able to supply wattless currents to other parts of the system. Such machines should be particularly useful where it is intended to feed power into a system of mains, as from a waste-heat station or from a small isolated water-power station, and where it is undesirable to connect a synchronous machine to the system; or, further, in a station having synchronous generators driven by reciprocating engines, the use of an induction generator in conjunction with an exhaust steam turbine and a phase advancer should be of great service.

"Asynchronous generators may also be of great service for light loads in towns liable to fogs in the winter months. Due to such fogs coming on quickly, it often happens that the load increases more rapidly than the attendants can parallel and switch in synchronous generators. In such cases there will be no difficulty in simultaneously starting up induction generators, which could be switched in circuit through choke coils, the latter being afterwards short-circuited. A further use for induction generators is in connection with slow-speed gas engines, such as are fed from coke-oven gas, and for use on 50-cycle circuits. The irregular turning moment of these engines and the great number of poles make parallel running rather difficult, particularly if the generators have to run in parallel with other machines to which they are connected by means of long lines. In such cases some at least of the generators could be advantageously made of the asynchronous type, and by means of phase advancers, could be made to take their share of the wattless currents.

"In general, phase advancers are designed for low voltage and a comparatively large current. They are fitted with compensating windings to ensure perfect commutation at all loads. Consequently, no sparking or burning takes place at the brushes and the commutator remains bright, requiring practically no attention. The brushes are of carbon and wear very slowly, so that they will only require to be renewed after a long period of continuous service. The phase advancers are designed either for direct coupling or for separate driving by belting, etc. For starting purposes, in conjunction with a motor, the only addition to the arrangement is a three-pole double-throw switch, which is required to switch in the advancer after the motor has been started in the usual way."

The unit referred to above has been tested by running it in conjunction with a 750 brake horse-power, three-phase, 50-cycles, 2,000-volt induction motor forming the motor end of one of two motor-generator sets which were run loaded back upon each other, the speed of each set being 590 revolutions per minute. The current passing through the machine was 600 amperes. The power taken to drive the phase advancer was about 1 per cent. of the power of the motor in conjunction with which it operated. The following table shows the readings obtained:

Reading.	Volts.	Kilowatts.	Power factor.	Remarks.
1	1,840	280	86% lagging.	Phase advancer not running.
2	1,840	300	Unity.	" " running
3	2,200	375	Unity.	" " "
4	2,600	375	50% leading.	" (increased speed)
5	2,000	20	50% leading.	" (speed as before)
6	2,600	312	40% leading.	" (increased speed)
7	2,560	20	5% leading.	" (speed as before)

NOTE.—The voltage was regulated by hand, to be constant for readings 1 and 2. A comparison of readings 3 and 4 shows a rise in the generator voltage due to the phase advancer having substituted leading and magnetising for lagging and demagnetising currents.

PRODUCER GAS POWER IN THE UNITED STATES.

A SUMMARY OF THE DIFFICULTIES IN THE WAY OF A MORE RAPID INTRODUCTION OF GAS-POWER PLANTS.

R. H. Fernald—United States Geological Survey.

AN exhaustive investigation of the development of the producer-gas power plant in the United States has recently been concluded for the United States Geological Survey by Prof. R. H. Fernald, whose report now appears as Bulletin 416 of the Survey publications. Nearly all of the 500 plants now in operation have been installed since 1900. They range in size from 15 to 6,000 horse power. About 12 per cent. are operated with bituminous coals and lignites; the remainder use anthracite or other smokeless fuel. The bituminous and lignite producers, however, represent about 57 per cent. of the total power capacity of the plants, and the capacity of the individual bituminous plants averages about 12½ times the capacity of the plants using anthracite.

The introduction of producer-gas power has progressed steadily during the past ten years. But when the superior fuel economy of the gas over the steam power plant is considered, it is not immediately apparent why the rate of progress has not been more rapid. The results of tests conducted by the United States Geological Survey with 75 coals, 6 lignites and one peat show an average ratio of fuel fired per brake horse power in steam-boiler compared with prducer plants of 2.7 to 1. A part of the voluminous data collected by the Survey in the recent investigation consists of the opinions of manufacturers and users of gas-power plants as to the difficulties in the way of a more rapid introduction of producer-gas power. From these opinions Prof. Fernald draws the general conclusions summarized below.

"1. It is still commonly believed that the gas engine plant cannot be so reliable as the steam engine. This obstacle to development is generally believed, by the manufacturers at least, to be largely due to lack of information. It is certain that gas-power plants are being operated with perfect reliability and satisfaction, where the conditions have been properly studied and the apparatus has been selected to meet these conditions.

"2. The lack of enginemen, experienced in operating producer-gas plants, is still a difficulty at times. The situation is much better than three years ago and this trouble will disappear in time.

"3. Inexperienced salesmen—men not familiar with the details of the engines and producers they sell and uninformed as to the conditions of selection of apparatus for best operation—are still in the field but, by attention from manufacturers, they are being eliminated.

"4. The influence of a large number of unsuccessful gas-power plants installed during the earlier period of development has not entirely been overcome by knowledge of the success of the best designs of reliable companies. Some unsuccessful installations are found in recent plants of the unexperienced manufacturers and also where some new designs have been tried out. Poor design and construction in some of the apparatus still being marketed reflect on all apapratus. The reliable companies offer a well tried, well built machine, which others imitate with a cheaper equipment having a similar appearance.

"5. Many factory buildings must be provided with a heating plant separate from the power plant, if a gas engine is installed. This prevents the sale of many gas-power units, which would be made if a satisfactory way were devised for this heating.

"6. While the investigations of the Survey have demonstrated that an excellent gas can be made from bituminous coals, yet the lack of types of producers which will *satisfactorily* gasify such fuels is still felt. In the 'up-draft' producer the mechanical extraction of tar is troublesome. In the 'down-draft' system the excessive labor in cleaning the fires prohibits the continuous operation of most single-generator plants. Inability to use still cheaper fuels has to be contended with. Although a few plants are operating successfully on lignite, there is opportunity for further development here.

"7. Lack of complete knowledge as to how successfully the various fuels in different localities can be used, while an obstacle at present, is being relieved by the work of the Geological Survey. As the results of its tests are published, information will become available concerning the various fuels of the country.

"8. The excessive first cost of gas-power over steam plants is felt. For the larger complete installations, say, from 4,000 to 5,000, the cost is about the same as of a first-class steam plant of the same capacity. With smaller installations the steam plant costs considerably less. Some manufacturers have stated that the high selling cost of gas-power plants is not warranted by the shop cost. This probably results from the cost of development of new apparatus and the expense of educating purchasers to the proper use of gas plants. Nevertheless, even if the steam plant costs 15 per cent. less than the gas plant, the increased efficiency in operating the latter will make up the difference within two or three years. This would hold true of course only where the hours of operation or of heavy load periods were long

enough so that the total decrease in fuel charges could equal or exceed the extra fixed charges.

"Producer gas-plants of 20 and 2,000 horse-power capacity cost from about $105 to $46, respectively, per horse power of installation, exclusive of buildings and foundations. Including buildings and foundations, these figures will be $108.50 to $47.50. Complete plants of the larger type from 1,000 to 5,000 horse-power capacity cost from $93 to $70 per horse power, including foundations, buildings and all auxiliaries.

"9. Over-rating of American producer plants has come about very naturally through the adoption of European figures for rates of fuel consumption in the days of early development. Experience has shown that American fuels are so decidedly different that equally decided modifications in the fuel rates must be made. Some manufacturers are now re-rating their apparatus, while others are still using grate areas too small for the loads on the producers. In inspecting a large number of installations throughout the country it was frequently observed that with good anthracite fuel no difficulty was experienced in working the producer up to 50 or 75 per cent. of the rated capacity, but if the apparatus was forced to its full rating for any length of time, clinkering and other operating difficulties were met. These were often sufficiently serious to necessitate a reduction in load at a most inconvenient time."

ELECTRIC MOTORS FOR MACHINE TOOLS.

A SERIES OF TABLES GIVING STANDARD SIZES AND SPEEDS OF MOTORS FOR DRIVING VARIOUS CLASSES OF MACHINE TOOLS.

Charles Robbins—American Society of Mechanical Engineers.

WE have already given in these columns* a summary of standard practice in the selection of motors for driving machine tools of various classes and in the application of the motors to the tools. In the tables following will be found a summary of the sizes and speeds of motors normally selected for this work. These tables appear as an appendix to an interesting paper by Charles Robbins on economic features of electric-motor applications, presented before the American Society

* THE ENGINEERING MAGAZINE, February, 1910.

TABLE I. SIZES AND SPEEDS OF MOTORS ON LATHES.

ENGINE LATHES.

Adjustable speed, ratio 1 : 3.

	LIGHT DUTY.			MEDIUM DUTY.			HEAVY DUTY.		
Swing, Inches.	Horse Power.	Adjst. Speed.	Const. Speed, r. p. m.	Horse Power.	Adjst. Speed.	Const. Speed, r. p. m.	Horse Power.	Adjst. Speed.	Const. Speed, r. p. m.
14	2	Ratio	1,800	3	Ratio	1,800	5	Ratio	1,200
16	3	1:3	1,800	5	1:3	1,200	5	1:3	1,200
18-20	3		1,800	5		1,200	7.5		1,200
22-24	5		1,200	7.5		1,200	10		1,200
27-30	7.5		1,200	10		1,200	15		1,200
36-48	7.5		1,200	10		1,200	20		900

SPECIAL LATHES.

Type.	Horse Power.	Adjustable Speed.
Car wheel, 48 inches	20	1:3
Double axle, moderate duty	15	1:3
Heavy duty	25	1:3

DRIVING-WHEEL LATHES.

Size, Inches.	Horse Power.	Adjustable Speed.
51	15	Ratio 1:3
60-69	20	
79	25	1,200 r. p. m.
84	25	
90	30	
100	50 5 tail stock	

TABLE 2. SIZES AND SPEEDS OF MOTORS ON VERTICAL BORING MILLS.

Size, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
24-30	5	Ratio 1:3	1,200
36-42	7.5		1,200
60-90	10 5-rail		1,200
100	15 5-rail		1,200
120	20 7.5-rail		900
144	20 7.5-rail		900
168	25 7.5-rail		900
192	30 10-rail		900

TABLE 3. SIZES AND SPEEDS OF MOTORS ON DRILLS.

RADIAL DRILLS.

Size, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
48	3	Ratio 1:3	1,800
60	5		1,200
72	5		1,200
120	7.5		1,200

UPRIGHT DRILLS.

Friction.	0.25	Ratio 1:3	1,800
15	0.5		1,800
20-26	1		1,800 1,200
28-34	2		1,800 1,200
42-50	3		1,800 1,200

MULTIPLE-SPINDLE DRILLS.

4-2	7.5	Ratio 1:3	1,200
6-2	10		1,200
8-2	10		1,200

TABLE 4. SIZES AND SPEEDS OF MOTORS ON MILLING MACHINES.

HORIZONTAL, PLAIN OR UNIVERSAL.

Table Feed, Inches.	Cross Feed, Inches.	Vertical Feed, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
24	8	18	3	Ratio 1:3	1,800
30	10	18	5-7.5		1,200
36	12	20	7.5-10		1,200
50	12	20	10-15		....

VERTICAL MILLING MACHINES.

Table Diameter, Inches.	Spindle Diameter, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
28	4	5	Ratio 1:3	1,200
32	4	7.5		1,200
40	4.5	10		1,200
54	5	15		1,200
70	6	20		900

SLAB MILLING MACHINES.

Width of Table, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
24-30	10	Ratio 1:3	1,200
36	15		1,200
60	25		900
36 heavy	25		900
42 "	50		900

TABLE 5. SIZES AND SPEEDS OF MOTORS ON HORIZONTAL BORING, DRILLING AND MILLING MACHINES.

Spindle, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
3.5	3	Ratio 1:3	1,800
4	5		1,200
5	7.5		1,200
6	10		1,200
7	15		1,200

TABLE 6. SIZES AND SPEEDS OF MOTORS ON PLANERS.

Medium Duty.			Heavy Duty.		
Size, Inches.	Horse Power.	Constant Speed.	Size, Inches.	Horse Power.	Constant Speed.
24x24	5	900	24x24	7.5	900
30x30	7.5	900	42x42	25	900
36x36	10	900	56x56	25	900
48x48	15	900	Frog and	30	900
56x56	15	900	Switch Forge	..	...
			12x10 feet.	60	720
				10 (rail)	...
			14x12 feet.	75	...
				12 (rail)	720

TABLE 7. SIZES AND SPEEDS OF MOTORS ON SHAPERS.

Size, Inches.	Horse Power.	Adjustable Speed.	Constant Speed.
14-20	3	Ratio 1:3	1,800
24	5		1,200
36	7.5		1,200

TABLE 8. SIZES AND SPEEDS OF MOTORS ON CRANK SLOTTERS.

Light, Medium and Heavy.				
Size, Inches.	Horse Power.	Medium.	Adjustable Speed.	Constant Speed.
10	3	5	Ratio 1:3	1,800
10-16	5	7.5		1,200
20	7.5	10		1,200
26-30	15	..		1,200
		Geared Slotters.		
24-60	20	..	1:3	900

TABLE 9. SIZES AND SPEEDS OF MOTORS ON COLD SAWS.

Diameter, inches.	Thickness, inch.	Horse Power.	Adjustable Speed.	Constant Speed.
12	5/32	2	Ratio 1:3	1,800
15	5/32	2		1,800
18	3/16	3		1,800
20	3/16	3		1,800
24	3/16	5		1,200
32	3/16	7.5		1,200
36	3/16	10		1,200

TABLE 10. SIZES AND SPEEDS OF MOTORS ON GRINDERS.

	Horse Power.		
Size, inches.	Medium.	Heavy.	Constant Speed.
10x 50	5	7.5	1,200
10x 72	5	7.5	1,200
10x 96	5	7.5	1,200
10x120	5	7.5	1,200
14x 72	10	..	1,200
18x120	10	15	1,200
18x144	10	15	1,200
18x168	10	15	1,200
18x 96	10	15	1,200
44-inch car-wheel grinder		30	900

of Mechanical Engineers and printed in the *Journal* for April. With Mr. Robbins' discussion of the method of handling a problem in motor drive in order to show its maximum economy, to which the paper proper is devoted, we have, unfortunately, no space to deal.

The tables show the sizes and speeds of motors usually employed with the average duty indicated for machine tools. The constant-speed motors are selected with a view to utilizing speeds as near as possible to those obtainable with 60-cycle induction motors. By this means the same gear ratios can be employed with either direct-current motors or 60-cycle induction motors.

Mr. Robbins has made extended studies of machine-tool operation which have demonstrated that few tools are in operation more than 50 to 60 per cent. of the time; the load factor in some cases may be as low as from 10 to 40 per cent. An analysis which took into account the time of loading, cutting, unloading, and the delays occasioned by miscellaneous

causes showed conclusively that it is not necessary to use a continuously rated motor; in fact, an intermittent rating on the motor for a period not exceeding two hours' continuous service answers for almost all kinds of machine-tool applications. The average load factor for motors driving lathes, for example, is from 10 to 25 per cent. On some special machines, as driving-wheel and car-wheel lathes, the cuts are all heavy, which increases the average load factor to from 30 to 40 per cent.

For extension boring mills, 5 horse-power motors are used to move the housings on from 10-foot to 16-foot mills, 7.5 horse-power motors for from 14-foot to 20-foot mills, and 10 horse-power motors for from 16-foot to 24-foot mills. The load factor of the driving motor on boring mills averages from 10 to 25 per cent. The load factor of motor-driven drills is about 40 per cent., when the larger drills applicable thereto are used. If the smaller drills are used the load factor averages 25 per cent. and lower.

For the average milling operations, the load factor averages from 10 to 25 per cent. On slab milling machines where large quantities of metal are removed it will average from 30 to 40 per cent. The work on this class of machinery is usually light and much time is required in making adjustments. Hence the load factor is rarely higher than 20 per cent. On planers the load factor averages between 15 and 20 per cent. The motor must be large enough to reverse the bed quickly, yet this peak load occurs for such short intervals that it does not increase the average load per cycle very much. The work done on shapers is of a very varying character. With light work the load factor will not exceed from 15 to 20 per cent.; with heavy work the load factor will be as high as 40 per cent. The conditions encountered on slotters are similar to those on shapers.

THE HARDENING OF TOOL STEELS.

A SUMMARY OF THE RESULTS OF A RESEARCH ON THE HARDENING OF CARBON AND LOW-TUNGSTEN TOOL STEELS.

Shipley N. Brayshaw—Institution of Mechanical Engineers.

IN a monograph which covers 159 pages, Shipley N. Brayshaw has communicated to the Institution of Mechanical Engineers the results of an exhaustive research on the hardening of carbon and low-tungsten tool steels, which constitutes a part of an investigation begun about seven years ago on the hardening of tool steels in general. The present paper deals exclusively with results obtained from two kinds of carbon tool steel, which, except for accidental variations, differed only in the fact that one of them contained about 0.5 per cent. of tungsten. These steels, Mr. Brayshaw finds, have a long range of quite 120 degrees C. (216 F.) within which they may be hardened to show a good fracture. So wide is the margin of allowable variation for hardening as ordinarily carried on, and tested by the appearance of the fracture, that a workman of average skill can easily keep within the limits, judging the temperature by sight alone. It is easy to harden so as to produce a good bar, but the production of the best bar necessitates a degree of accuracy beyond what can be attained by sight alone. Further, the difference between the good bar and the best bar is very great. Mr. Brayshaw does not advocate that all tool-steel hardening should be carried on with the precision necessary to bring the steel into its best condition, but he believes it possible to bring the various operations connected with steel hardening under such control, by means of methods of precision, that different hardeners in different places should be able to produce exactly similar results from the same hardening instructions.

A summary of the voluminous data accumulated by Mr. Brayshaw in his investigation of precise methods of control for carbon and low-tungsten steel hardening is given below. The six steels on which the experiments were made

had the following percentage compositions:

	W 1	W 2	W 3	W 4	A 1	A 2
C	1.18	1.16	1.19	1.15	1.16	1.14
Si	0.18	0.10	0.23	0.21	0.07	0.09
Mn	0.42	0.37	0.28	0.31	0.37	0.40
W	0.47	0.48	0.57	0.50	...	...
S	0.023*	0.023	0.012*	0.012*	0.018*	0.018
P	0.014*	0.014	0.011*	0.011*	0.014*	0.014

*Approximate.

All heating was done by immersion in a hot liquid in a special furnace designed by Mr. Brayshaw. Molten lead and alloys were given a prolonged trial, but the mixture finally chosen was a patent melt mainly composed of the chlorides of sodium and potassium.

From an examination of the heating and cooling curves of low-tungsten steel, Mr. Brayshaw concludes that if the temperature has been raised up to or beyond 880 degrees C. (1,616 F.) it is more difficult for the steel to change into the post-recalescence condition; that is to say, that at about the temperature of 880 degrees C. the point of subsequent recalescence is lowered and also rendered much less liable to alteration by the rate of cooling. An investigation of the influence of maximum temperature and rate of cooling upon the recalescence (designated Ar 3, 2, 1) shows that the recalescence of low-tungsten steel takes place gradually at a temperature of 731 degrees C. (1,348 F.) and more readily at 725 degrees C. (1,337 F.); further the recalescence at either of the above temperatures is very much retarded if the steel is cooled from a maximum heat of 890 degrees C. (1,634 F.). There is a post-recalescence condition of low-tungsten steel reached by first heating above the halt on the heating curve (designated Ac 1, 2, 3) and then immediately soaking at certain temperatures between the halts Ac 1, 2, 3 and Ar 3, 2, 1. If the steel is quenched from this condition it is softer than the same steel which has been quenched after merely soaking at these temperatures between the halts Ac 1, 2, 3 and Ar 3, 2, 1, without having undergone the previous higher heat.

Bending tests on bars, to determine the effect of heating to various temperatures, demonstrated that the hardening point of both low-tungsten and carbon steel may be located with great accuracy. The complete change from soft to hard is accomplished within a range of less than half a dozen Centigrade degrees (11 degrees F.). The hardening point so ascertained coincides of course with the halt Ac 1, 2, 3 on the heating curve of the same steel. After the temperature has been raised more than 20 or 30 Centigrade degrees (36 to 54 degrees F.) above the hardening point, the hardness of the steel is lessened by further increases in the temperature, provided that the heat is sufficiently prolonged for the steel to acquire thoroughly the condition pertaining to the temperature. There is a change point at about 880 degrees C. (1,616 F.) in low-tungsten steel and at a somewhat higher temperature in carbon steel. One of several indications of this change point is the shortening of bars hardened in water from temperatures below the point, whereas the bars lengthen if the temperature in question is exceeded at the time of quenching. Practically the same results are obtained by heating low-tungsten bars to any temperature from 760 to 940 degrees C. (1,400 to 1,726 F.) and quenching in oil.

Prolonged soaking for hardening at a temperature of about 760 degrees C. (1,400 F.) has a slightly injurious effect but does not materially affect the hardness. At a temperature of about 810 degrees C. (1,490 F.) a great degree of hardness is attained with a short time in the melt, and the hardness is impaired with 30 minutes' soaking. Prolonged soaking for hardening at a temperature of about 880 degrees C. (1,616 F.) has a seriously injurious effect upon the steel. A specially great degree of hardness may be attained by means of soaking at a high temperature such as 880 degrees C. (1,616 F.) for a very short time, but even 7 1-2 minutes is long enough seriously to impair the hardness. As to the temperature of brine for quenching, both low-tungsten and carbon bars quenched at 5 degrees C. (41 F.) are decidedly harder than bars quenched at 24 degrees C. (75 F.) and quenching at 51 degrees C. (124 F.) renders the bars much softer.

The elastic limit of low-tungsten bars hardened at either 760 or 860 degrees

C. (1,400 or 1,580 F.) varies greatly according to the annealing they have undergone. The elastic limit is high after annealing at 800 degrees C. (1,472 F.) for 30 minutes or 700 degrees C. (1,292 F.) for 120 minutes, but it is seriously impaired by annealing at 800 degrees C. for 120 minutes. If low-tungsten bars are annealed at 940 degrees C. (1,724 F.) and hardened at 760 degrees C. (1,400 F.) the elastic limit is inferior, and the adverse effect of the previous annealing is much more pronounced if the hardening is done at 860 degrees C. (1,580 F.). The elastic limit of carbon bars annealed at any temperature from 700 to 940 degrees C. (1,292 to 1,724 F.) and hardened at either 760 or 860 degrees C. (1,400 or 1,580 F.) does not vary by nearly such great amounts as the elastic limit of similar low-tungsten bars, and, furthermore, the highest annealing temperature given above is not injurious so far as the elastic limit is concerned. The hardness of low-tungsten bars hardened at 760 degrees C. (1,400 F.) decreases from a high scleroscope figure to a low one as the temperature of annealing increases from 700 to 940 degrees C. The hardness is increased by prolonging the annealing at the lower temperatures. The hardness of low-tungsten bars hardened at 860 degrees C. (1,580 F.) is fairly constant at a moderately high scleroscope figure whatever the tempeature of annealing.

An extended investigation was made of two-furnace heats for hardening, the process of heating the bars first in one furnace to a certain temperature for a given time and then immediately, without intermediate cooling, soaking in a second furnace at a known temperature and time. The results show that low-tungsten and carbon bars heated for 30 minutes to temperatures of 840 to 900 degrees C. (1,544 to 1,652 F.) are not much affected so far as their elastic limit and maximum stress are concerned by a further immediate soaking for 30 minutes at 760 degrees C. (1,400 F.). If, however, the temperature in the first furnace is 940 degrees C. (1,724 F.) the low-tungsten steel is much improved by the further soaking at 760 degrees C., but the carbon steel is much injured by the same treatment. Bars of this low-tungsten steel heated for 30 minutes to 880 degrees C. (1,616 F.) and then soaked at 722 degrees C. (1,332 F.) for a further 30 minutes give a higher elastic limit and maximum stress, and are harder than if the second soaking were at a temperature of 760 degrees C., but the carbon steel is little affected by these variations in the second furnace.

The change in length of both low-tungsten and carbon steel bars is much affected by the above variations in the temperature of the second furnace. Very good results as regards the elastic limit and maximum stress and also as regards the hardness, are obtained by a very short soaking, first at a high temperature (say 880 degrees C.) and then at a low one, and the results are best of all when the second temperature is near to or a little below the hardening point. If the first furnace be at a sufficiently high temperature it is easy, either by variations in the temperatures of the two furnaces or by variations in the times therein, to arrive at a treatment by which the bars (both low-tungsten and carbon) neither lengthen nor shorten in hardening. Under the same treatment the carbon bars have a greater tendency to shorten than the low-tungsten.

Experiments on the tempering of bending-test bars are described in which little effect was produced by the tempering at 150 degrees C. (302 F.) for 30 minutes of both low-tungsten and corbon steel bars which had been hardened by a certain process. The tempering at 250 degrees C. (482 F.) for 15 minutes of a well hardened carbon steel bar caused it to soften considerably and to shorten in length, but it was little affected otherwise. In experiments on low-tungsten bending-test bars which had been hardened by a rapid process it was found that the elastic limit was much increased by tempering up to a temperature of 250 degrees C. (482 F.). The maximum stress coincided with the elastic limit in two hardened bars, one of which was untempered and the other tempered at about 150 degrees C. (302 F.) for 15 minutes, but it rose rapidly above that point with further tempering. The deflection due to a given load less

than the elastic limit was greatest for the hardened untempered bar and it decreased with the tempering up to 198 degrees C. (388 F.) for 60 minutes. The hardness, as measured by the scleroscope, was considerably reduced by tempering at 150 degrees C. (302 F.) and again by tempering at 200 degrees C. (392 F.), but was not so much affected by further tempering at 250 degrees C. (482 F.). The length of the bars was reduced by tempering up to a temperature of 250 degrees C. and the higher the temperature the greater the reduction in length.

Tensile tests of low-tungsten steel bars showed results which there is no reason to doubt are applicable also to bars of carbon steel. A variation in the hardening temperature of only 5 degrees C. (9 F.), the extremes being respectively above and below the halt Ac 1, 2, 3, had a powerful influence upon the extension under load and doubtless upon the permanent extension, but the maximum stress of the bars so treated did not differ much. A very good bar was produced by quenching from a temperature fully 60 degrees C. (108 F.) above the halt Ac 1, 2, 3. A heat of only 5 minutes duration produced a harder bar than a heat of 25 minutes, the maximum temperature in both cases being 800 degrees C. (1,472 F.) or a little above. On the other hand, the bar which was heated for the shorter time gave a much lower elastic limit. Neither the maximum stress alone nor the hardness alone is necessarily any indication of the general condition of the steel in question, or of the treatment to which it has been subjected.

The effect of tempering up to 300 degrees C. (572 F.) well hardened bars of both low-tungsten and carbon steels was greatly to increase the maximum stress and the elastic limit, but there were some irregularities which were not fully accounted for. Tempering to this temperature reduced (for a given stress) the extension under load and the permanent extension. The greatest effect was produced between the temperatures of 200 and 250 degrees C. (392 and 482 F.). Little effect was produced by prolonging the tempering at 250 degrees C. from 15 to 30 minutes.

THE HOMOGENEITY OF METALS.

A DISCUSSION OF THE INFLUENCE OF HOMOGENEITY ON THE DURABILITY OF STEEL, WITH PARTICULAR REFERENCE TO STEEL RAILS.

Gregory Tagayeff—Iron and Steel Institute.

MICROSCOPIC metallography has demonstrated conclusively that a large proportion of the failures of metals are due less to improper composition for the special purposes to which the metals are applied, than to irregularities of structure in the metals. At the recent annual meeting of the Iron and Steel Institute, M. Gregory Tagayeff gave an admirable summary of the established facts regarding the influence of non-homogeneity of structure on the durability of metals. M. Tagayeff is the author of a report on the homogeneity of rails and the study of structure as a method of testing, which is based on the results of an exhaustive investigation of rails taken from Russian railways. The conclusion expressed in this report as to the importane of homogeneous structure in securing satisfactory service are summarized in his present paper. We reproduce them in the following paragraphs.

"Data derived from the study of the chemical composition, in connection with the wear of rails, do not afford an explanation of the difference in their service. Observation of the service of rails and of other articles (shafts, axles, propeller screws, etc.) indicates that local defects have a predominant influence on their endurance. Flaws and defects observed in rails are particular evidences of non-homogeneity of their internal structure. In order to explain this properly it is necessary to call in the aid of metallography, which studies the structure of metal.

"Structure of steel is determined: (*a*) by the particular arrangement of the different constituents of the alloy (phases) resulting from its physico-chemical equi-

librium as represented graphically by melting curves; (*b*) by the external features of these structural elements (form, size, and distribution) resulting from the so-called structural equilibrium, which depends upon the conditions of initial temperature, rate of cooling, cooling temperature, and external mechanical influences, the sum of which constitutes the mechanical and thermal treatment.

"A comparison of the results of fractures, with data from microscopical investigation, can be of great use. In particular, such a comparison confirms the existence of a constant definite correlation between the fracture and the microstructure of steel. The mechanical properties of steel are the resultant of the whole of the properties of the structural elements which the steel contains. The mechanical properties of a metal and its quality, as measured thereby, are functions of the structure. For this reason the structure affords an indication of the strength and endurance of a manufactured steel article.

"The investigation of the deflection of rails by calculation, or by direct measurement of the distortion, does not afford a sufficient explanation of their differences in service and of their defects when in track. Investigation of the microstructure, on the other hand, reveals the presence of strains in the head of a rail due to non-homogeneity of the metal. These strains considerably exceed those calculated from an investigation of the deflection. The predominant influence of impact action in the fracture of a rail in position depends also upon the degree of homogeneity of the metal (limit brittleness).

"The service wear of rails depends both upon the absolute properties of the metal (chemical and morphological composition) and upon a certain relative property due to the distribution of the elements of the metal, that is, its homogeneity. The influence of homogeneity in rails affects their service in all cases considerably more than the action of the separate properties of the metal itself. The extent of homogeneity in rails can serve as an indication for classifying them relatively to the results of their service. The non-homogeneous rails will always be either corrugated or brittle or worn down, according to the character and the local conditions of non-homogeneity in each particular case, without it being possible to establish a hard and fast line between the separate groups of such defective rails. The classification of rails, as adopted in practice, into crushed, brittle, and worn out, only distinguishes them by external appearance, without touching upon the manner and cause of their failure. In particular, the presence of so-called gas bubbles, honeycombs, small porosities, and permeations of ferrous oxide contribute to increase the amount of wear likely to occur, while ghost lines (decarburised surfaces of ferrite, permeated by foreign substances) conduce to brittleness. An irregular distribution of ferrite and pearlite promotes crushing. Sulphide of manganese is absolutely injurious to the strength of rails when segregated and accompanied by cracks.

"The cause of non-homogeneity in rails must be sought for in the various stages of manufacture previous to rolling (the molten metal, and the casting and heating of the ingots), in the rolling itself, and in the conditions of subsequent cooling. Hot rolling and prolonged cooling induce non-homogeneity in the cross section of rails, and lower the mechanical properties of the metal. The non-homogeneity of hot-rolled rails manifests itself by the predominance of ferrite in the periphery of the cross section of the rail, by the difference in the size of the grain, and by the lowering of the elastic limit in the central portion of the head.

"The degree of homogeneity or non-homogeneity can be estimated by the amount of variation of any one of the mechanical properties; as, for instance, that of the limit of elasticity, which best expresses the treatment undergone by the metal. The calculation of the non-homogeneity coefficients of a rail, at its cross section, according to this principle, shows that:—(*a*) satisfactory wear of rails is only possible with a sufficient margin of homogeneity; (*b*) the crumpling of rails is directly proportional to the non-homogeneity of the cross section; (*c*) the coefficient of non-

homogeneity in crumpled rails is from five to fifteen times greater than in the case of rails which have preserved their profile after service in the track; (*d*) the homogeneity in rails which have served satisfactorily is five times greater than in crumpled rails.

"Investigation of the structure renders it possible to establish several typical forms which indicate positively unsatisfactory service of manufactured articles of steel. An example is the ramified structure of pearlite in soft and mild steel for axles and rails."

THE ELECTRICAL IGNITION OF COAL DUST.

A REPORT OF AN EXTENDED INVESTIGATION OF THE IGNITION OF COAL DUST BY SINGLE ELECTRIC FLASHES.

W. M. Thornton and E. Bowden—Institute of Mining and Mechanical Engineers.

AN exact scientific basis for the discussion of the vexed question of the liability of coal dust to ignition by electric flashes is provided in a recent paper read before the North of England Institute of Mining and Mechanical Engineers by Dr. W. M. Thornton, reprinted in the *Iron and Coal Trades Review* for April 15. Dr. Thornton and his associate, Mr. E. Bowden, have made upwards of 2,200 experiments with inductive and non-inductive currents, both alternating and direct, at various voltages and intensities, and have succeeded in determining the exact conditions under which dust can be fired by electricity. The data given in the paper are much too numerous for complete reproduction, but the abstract following summarizes all the essential conclusions.

Dr. Thornton first discusses briefly the properties of coal dust under electrification. Dry coal in bulk or in the form of dust is not a conductor of electricity. It undergoes no change when placed for several months between terminals 1 inch apart carrying 480 volts, nor when mixed into a paste with oil is there any change to be detected electrically. If, however, a paste made of coal dust and water is placed between terminals 1 inch apart on a marble base and electrified by either direct or alternating current at 480 volts, sparks pass through the substance of the paste and eventually a large flash strikes across, short circuiting the terminals. This result is not due solely to the presence of water, nor is it due to the conductivity of the flame. It is probably caused by the establishment of a line of carbonized particles of the dust short circuiting the terminals. Again, although a flame caused by the slow combustion of hydrocarbons will not short circuit terminals under moderate pressure, it can be shown that the vapor of a fuse when blowing will do so. A point of some practical importance arises from this. When electric cables are brought along a mine roof, they are sometimes taken into a distributing box from the top. In the event of one of the inner fuses blowing hard, the dividing partition not being sound, the vapor can short circuit the main distributing bars and cause a flash over with all the power in the mains behind it. If, however, the cables are brought in from below, the fuse clears itself without risk to the circuit.

The dust used in the experiments was a mixture of dusts from three different mines. It was not sieved before use and contained 10 per cent. of ash, chiefly calcareous. "The apparatus consisted of a stout wooden box, with a hinged lid, in which was a glass window. The dust was blown in by foot bellows through a ¼-inch glass tube from a storage bottle. Through the sides of the box brass rods were fitted, one fixed, the other free to slide in a sleeve, and with a stout spring so arranged that by a trigger a quick break could be made between the poles if desired. When the free rod was fully drawn back, the distance between the poles was 2½ inches. When testing the action of fuses, two spring contact makers were slipped over the poles and the fuse inserted between them. After each ignition the air in the box was swept out. The break was always at the same rate, and after practice the draft could be adjusted to give always the same cloud."

TABLE I. QUICK BREAK; 100 VOLTS; DIRECT CURRENT; NON-INDUCTIVE.

Amperes.	Trials.	Ignitions. Full.	Ignitions. Partial.	Percentage of ignitions.
40	57	0	0	0.0
75	20	0	1	2.5
84	30	1	2	6.6
90	20	1	2	10.0
110	20	3	2	20.0
120	62	10	10	24.0

Least current causing ignition, 70.3 amperes.

TABLE II. QUICK BREAK; 240 VOLTS; DIRECT CURRENT; NON-INDUCTIVE.

10.8	15	0	0	0.0
12.0	31	0	3	4.8
15.5	22	0	5	11.3
18.0	44	0	21	24.0
27.0	23	3	16	48.0

Least current causing ignition, 11 amperes.

TABLE III. QUICK BREAK; 480 VOLTS; DIRECT CURRENT; NON-INDUCTIVE.

5.79	33	0	0	0.0
6.67	37	3	0	8.1
7.14	39	7	0	18.0
7.65	30	6	0	19.8
10.3	20	12	0	60.0
13.0	10	10	0	100.0
25.0	10	10	0	100.0 (violent)

Least current causing ignition, 5.8 amperes.

TABLE IV. QUICK BREAK; DIRECT CURRENT; INDUCTIVE CIRCUITS.

Volts.	Amp.	Trials.	Ignitions. Full.	Ignitions. Partial.	Percentage of Ignitions.
100	14	20	0	0	0.00
	19	20	1	3	12.50
	32	11	5	6	72.00
235	5.5	48	0	0	0.00
	6.8	38	0	4	5.27
	9.0	37	0	12	16.20
470	1.9	20	0	0	0.00
	2.9	20	0	4	10.00
	5.5	20	6	9	52.50

Least currents causing ignition were 16, 5.7 and 2.3 amperes respectively.

TABLE V. SLOW BREAK; DIRECT CURRENT; NON-INDUCTIVE.

110	7.8	33	0	0	0.0
	10.0	26	1	2	7.7
	16.0	38	17	15	61.5
235	1.45	20	0	0	0.0
	1.90	22	0	2	4.5
	2.10	24	0	10	21.0

TABLE VI. QUICK BREAK; ALTERNATING CURRENT; NON-INDUCTIVE; FREQUENCY, *n*.

77	170	50	0	2	2.0
$n=40$	300	52	2	2	5.8
100	85	32	0	0	0.0
$n=80$	112	40	0	0	0.0

Least current, 100 amperes at 77 volts.

TABLE VII. LEAST CURRENT WHICH IGNITES COAL-DUST, WHEN INTERRUPTED BY A QUICK-BREAK SWITCH.

	Amperes. D. C.		Amperes. A. C.		Alternating Current
Volts.	Induct.	Non-Induct.	Induct.	Non-Induct.	Power-factor.
77	....	....	....	100	0.75
100	16.0	70.3	140.0	...	0.80
240	5.7	11.0	....	...	....
280	....	....	36.0	...	0.80
480	2.3	5.8	14.2	...	0.81
635	....	....	5.2	...	0.83

In coal-mining practice there is little risk of the production of an electric flash in a dangerous place through the fusing of a wire. Attention was therefore concentrated upon flashes produced by the quick breaking of circuits under different conditions of voltage and current. The first experiments were made with direct current, and the circuit was kept non-inductive, the case least favorable to ignition. The object was to find the smallest current which would fire dust, and, if possible, that which always caused ignition. In many cases the ignitions were only partial, and the results have been divided into full and partial ignitions; no case can be considered safe, however, where there is even a partial flare. For the purposes of tabulation, two partial ignitions have been taken as equivalent to one full ignition.

Tables I to III show that with direct, non-inductive current the increase of percentages of ignitions is proportional to the increase of current. The curve obtained by plotting the ratios of change of percentage to corresponding change of current as ordinates and the voltages as abscissae follows nearly a square law; that is, the increase of percentage per ampere is proportional to the square of the voltage. The percentage is, therefore, not proportional to the power of the flash, but to the product of this and the voltage. For a given voltage it has a linear relation to the current; so that the risk of ignition is proportional to the volume of the flash.

In practice direct-current motor circuits are to be classed as inductive, although the field coils are connected across the armature when running and do not affect the flash at break of the main circuit. Experiments were made with an inductance of 1.08 henries, the results of which are shown in Table IV. Comparing the inductive with the non-inductive cases, it will be seen that the influence of inductance has been to lower the limit of safety by one-half at least, and in the 100-volt case to nearly one-fifth of its value in non-inductive circuits. The results of experiments to determine the effect of a slow break, as when a cable parts under a gradually applied load, a condition imitated by

drawing the poles slowly apart by hand, are shown in Table V. As might be expected, currents broken in this way were found more liable to produce ignition than when interrupted quickly. In the 480-volt tests, with a current of 0.3 ampere there was one slight ignition; with 0.65 ampere, occasional full ignitions; with 0.9 ampere, ignitions almost every time; and with 1.15 amperes, every flash caused ignition.

In the case of alternating currents, there should be less risk from breakage of cables, on account of the chance that the arc may break in passing through zero current and may not be able to re-establish itself. On the other hand, if the current breaks at the crest of the wave, the flash is larger than for equivalent direct current; this, however, occurs very rarely. The results of experiments with non-inductive alternating currents, using a resistance giving a power factor of 0.92, are given in Table VI. It was not possible to obtain non-inductive currents higher than 112 amperes at 100 volts, and the lowest direct voltage used was 100, for which the least current on non-inductive circuits was 70.3 amperes. It is clear from these figures that the values in the case of alternating currents is not far short of twice that for direct currents. A large number of trials were made with the power factor kept as nearly as possible 0.8, with some inductance and a frequency of 40. The results are summarized in the fourth column of Table VII.

TABLE VIII. RELATIVE SAFETY OF ELECTRIC CURRENTS AT DIFFERENT VOLTAGES.

Volts.	Direct non-inductive currents.	Direct inductive currents.	Alternating currents.
100.....	1.0	0.228	2.00
200.....	1.0	0.407	3.56
300.....	1.0	0.438	3.54
400.....	1.0	0.338	2.78
500.....	1.0	0.354	2.09

TABLE IX. QUICK-BREAK OF CURRENT.

Voltage.	Least current.	Certain current.	Ratio.
100 direct current..	....70.3	270.0	3.80
240 " "	.....11.0	44.2	4.00
480 " "	..... 5.8	13.0	2.20
1,000 alternating current	4.1	6.4	1.56

Taking direct, non-inductive current as the standard, the relative safety of electric currents at different voltages can be expressed as in Table VIII. The safety ratio of alternating to direct currents increases and then decreases. The risks of ignition are more equal at lower voltages because of the larger volumes, and at higher voltages because of the longer duration of the flashes. The fact that at any given voltage the increase in the percentage of ignitions is proportional to the increase of current, suggests that in any case the probability of ignition is proportional to the volume of the arc; that is, since the arc is drawn out in the same way in each case, to the surface in contact with the dust. The currents required to ignite dust with certainty at every flash are given in Table IX. At higher pressures the ratio is unity; that is, every flash produces ignition whatever the current may be.

Trials were made to compare the action of a blowing fuse on direct and alternating currents with the effect of quick break of circuits. From these it is concluded that:—(1) the more violently a fuse blows, that is, the greater the ratio of the current in the circuit to the fusing current of the wire, the greater is the risk of ignition; (2) the ratio of percentage of ignitions of direct to alternating currents for the same voltage and current is four to one; (3) the nature of the fuse wire does not appear to have much influence; and (4) the least current for ignition is comparable with that for direct non-inductive circuits, probably less in the ratio of 0.7 to 0.8, that is, there is from 40 to 25 per cent. more risk from a fuse than from the same current broken quickly. The determining factor in each case is the volume and duration of the arc.

Certain practical conclusions may be drawn from these results. "Coal dust, although an insulator when dry, becomes a conductor if wet enough for carbonization to take place. The necessity for keeping commutators clean, especially the small gap between live copper and the frame, is obvious. There appears to be no danger of flashing over on 480 volts between live parts 1¼ inches apart unless the deposit of dust is entirely conducting, as from carbon brushes.

"Distributing boxes should be dust and flame tight, and should be in compartments so arranged that the main terminals cannot be short circuited by a

flash. Cartridge fuses should be always used where possible, and once used should not be replaced by bare wire or by running wire through an empty tube. Momentary arcs produced by break of cables or conductors can ignite dust; but the current required to do so is very much greater when the voltage is low, and at moderate voltages is greater for alternating than for direct current. This suggests that the arrangement most satisfactory from the point of view of safety, both for flashes and for shocks, is high-tension transmission to a sub-station or transformer house, probably with cables well enough armored to prevent any external flash, and quite low-tension local transmission for power and lighting. Series lighting with incandescent lamps is not to be recommended.

"Although it has been shown that a cloud of coal dust can be ignited by small single flashes, it does not follow that the use of electricity in collieries is dangerous. Electricity is no more dangerous than the supply for domestic use of highly poisonous and explosive coal gas. An efficient leakage indicator is equally necessary for both. No indicator will prevent risk from sudden breakages of either pipes or cables; but in the electrical case there is the advantage that the main supply can, if desired, be cut off by a small leakage current."

PROBLEMS OF REFRACTORY MATERIALS.

A SUMMARY OF PRESENT-DAY NEEDS IN REFRACTORY MATERIALS IN VARIOUS INDUSTRIES.

Kenneth Seaver—Engineers' Society of Western Pennsylvania.

A PAPER by Kenneth Seaver, one of a symposium on present-day needs in structural materials, recently discussed in the Engineers' Society of Western Pennsylvania and printed in the *Proceedings* for April, deals with the unsolved problems of refractory materials. In an early number of THE ENGINEERING MAGAZINE we hope to present to our readers a critical discussion of the methods of mining and fabricating fireclay by A. S. B. Little, to which the lengthy abstract of Mr. Seaver's paper following will serve as a useful introduction.

"Naturally, the problems relating to high refractories are incapable of an exact and mathematical answer, and the problem of the blast furnace, for instance, the old type furnace using cold blast, required another solution with the advent of the hot-blast stove, and as this was in turn succeeded by the still more modern types with greatly increased temperatures and vastly larger volumes of wind, still further development was necessary in the matter of its lining. Within the last few years the constantly growing use of the Mesaba ores and of the difficulty reducible magnetites, as well as the very refractory Cuban ores, and the increased percentage of flue dust in the furnace burden, each brings its new problem not only to the blast furnace engineer, but to the producers of refractory material.

"In general, it may be stated that the problem involves three factors, or some combination of these factors, the inclusion of extreme heat as one being, of course, axiomatical, while besides this, there is the factor of chemical action, as well as mechanical or physical abrasion. In any given problem there may be but one, two or all three of these factors."

In the blast furnace the temperature ranges from 400 to 600 degrees F. at the top to 3,500 degrees F. opposite the tuyeres. The chemical factor is one about which comparatively little is known and which offers a wide field for further investigation. One theory offered to account for the fluxing of linings is that cyanogen formed by the action of nitrogen on incandescent coke unites with any sodium and potassium present; the resulting cyanides are reduced to carbonates as they pass upward in the furnace, and the alkaline carbonates act on the lining to form comparatively easily fusible silicates. There is, however, little real information on the subject.

Abrasion in the blast furnace is, of course, most severe at the top, though it has an important effect on the entire furnace shaft until very near the zone of

fusion. The use of ores containing zinc, such as are peculiar to the Virginia fields, introduces a serious problem. The metallic zinc deposited from the zinc vapors in the more or less permeable lining causes enormous distortion of the furnace. A material is demanded which shall combine the properties of refractoriness, resistance to abrasion, and ability to withstand the action of zinc. Another problem is presented by the newest type of blast furnace with the so-called "thin" lining, in which only the highest grade of refractory, and that satisfactorily prepared, has any chance of giving proper results.

"In the hot-blast stove, not only must the brick withstand the high temperatures and repeated stresses caused by the changes in such temperatures, but also the markedly disintegrating action of the gases. It must also have proper physical strength to bear the weight of the superimposed mass of brickwork of 100 feet or more. The failure to solve this latter problem has, in one instance, resulted in the necessity of shoveling out the stove complete within a year, whereas the successful solution may mean from 14 to 15 years' run.

"Each year sees a constant increase in by-product coke oven construction. Its development is bringing up new problems. The refractories originally deemed entirely satisfactory have since been discarded by all advanced designers, and new refractories capable of withstanding higher heats and with much greater conductivity are employed. The question of minimum expansion or contraction is here an all important one, as well as the ability to withstand abrasion. The beehive oven, comparatively simple as its questions may seem, has seen and is seeing great progress as well. As a rule, the materials once employed are by no means satisfactory when viewed from the modern economic operating standpoint. This is particularly true with the use of the high volatile coals such as occur in the Klondike and other regions.

"Connected with this problem of beehive refractories is that of waste heat flue construction. Experiments have been conducted along these lines for a number of years, and with one of the largest coke oven operations in this country had come to such a pass that, regardless of the large saving, the feasibility of the whole scheme depended on the finding of a suitable fire brick or silica brick which should withstand the intense heats encountered in the underground flues and at the same time avoid any difficulty from spawling. This question has apparently been satisfactorily solved, and marked economics can be looked for in its adoption.

"In the rotary cement kiln, the lining of which has to withstand not only the high heats and the abrasion of its charge, but the chemical action of the highly heated basic cement clinker, there are introduced secondary problems by no means unimportant in every change of mix. It is, of course, the aim that the lining should have such mechanical and chemical characteristics as shall enable it to pick up and hold a coating of clinker. Otherwise, the fire brick itself would be rapidly destroyed.

"In the ever recurring problem of maximum production at minimum cost, the aim has been to secure in retort gas house practice, material which shall give much longer life than the old clay retorts, shall withstand higher heats and shall have increased conductivity, so that the gasifying of the coal may be done in a shorter time and at decreased fuel consumption. The results of recent tests show this problem is in at least a very fair way of solution.

"Although in general the type of refractories used in open hearth work has seen little change, there is constantly the search for fire clay, silica, magnesia and chrome brick which shall give even a longer life, and the relative importance of refractories in this phase of the steel industry can be readily appreciated. The development of the electric furnace is the occasion of much research for refractories peculiarly adapted to its needs, and although the silica and magnesia brick in use in the open hearth are now employed, there is a search for other materials, should they be available.

"The question of a satisfactory retort for the distillation of zinc is as yet by no means solved. So near the temperature of fusion of the retort is it neces-

sary to carry the heats in order to secure the volatilization of the zinc that there is but the narrowest factor of safety, and thus far, the effect of the various oxides is such as to preclude the use of certain refractories which otherwise might give good results. Much experimentation is going on, with the idea of lining clay retorts with chrome, but it is as yet too early to predict the final outcome.

"Enormous developments bid fair soon to occur in certain types of calcining kilns, these kilns making available deposits of iron ore which were formerly, due to the high sulphur content, not economical to roast. In the particular type of kiln in mind, there is the introduction of a muffle by which the sulphur gases are kept separate from the combustion gases, and are employed in the manufacture of sulphuric acid. Here the great conductivity of magnesite is the essential.

"In addition to the three factors which in general we have already considered, there is yet a fourth which we may term the personal equation and which is yet a most vital factor, that is, the treatment which the refractory receives at the hands of the user. In the same type of furnace a given refractory may give excellent results while operated by one, but be a complete failure in the hands of another. Knowledge and care in the operation of the furnace is all-important.

"There is yet another problem which we have not mentioned, and that is, the problem of the education of the user of refractories to an appreciation of what quality means and to a realization that cost must be figured on a tonnage output and not on the original price per thousand. In numberless instances the solution of refractory problems is but a question of bringing the consumer to realize that there is at hand a remedy for his troubles, if he will but accept it.

"That the progressive manufacturer is seeking to the best of his ability, a solution of these problems, is evidenced by the increasing amounts expended for research along all lines which may seem to bear upon it, and the discussion of these problems in the literature of to-day is undoubtedly having a great and beneficial effect. Undoubtedly one reason for the comparatively slow adoption, by the consumer, of certain grades of fire brick and silica brick, has been due to the lack of information of the manufacturer as to the exact conditions to be fulfilled. This has been due, in a measure, possibly, to a lack of initiative on the part of the latter and also to a mistaken policy of secrecy on the part of the former, but this is passing and there is coming to be a full realization that only by the heartiest co-operation and exchange of ideas can there be an efficient and satisfactory solution of the problems."

THE OIL SHALES OF EASTERN CANADA.

A REPORT OF AN INVESTIGATION OF THEIR ECONOMIC POSSIBILITIES.

R. W. Ells—Canadian Department of Mines.

THE utilization of bituminous shales for the production of illuminating and lubricating oils, paraffin, ammonium sulphate and other chemical products is an industry which still persists only in Scotland. The Scottish oil industry dates from 1848, when a small spring of petroleum was found in a coal mine in Derbyshire. After the failure of this supply, within a few months of its discovery, the distillation of crude oil from bituminous coal was attempted, but experiments with bituminous coals were abandoned on the discovery in 1850 of the Torbanehill mineral, a cannel coal yielding over 6 per cent. of volatile matter. The utilization of oil shales began in 1862, when the torbanite deposits were exhausted.

The history of the oil-shale industry is one of a constant series of improvements in the process of extracting the crude oil and of its subsequent fractional distillation. Financially, however, the industry has not been continuously successful. Ammonium sulphate is now one of the leading by-products and one of the principal sources of profit from the distillation of oil shales. The wide fluctuations in the market price of this

material have from time to time threatened the industry with extinction, but at the present prices of ammonium sulphate and the other products of oil-shale distillation, the condition of the industry is one of prosperity. The number of active companies has declined from 51 in 1871 to 6 in 1906, but in spite of this reduction, the output has not decreased. The total production in 1906, 2,545,582 tons, yielded:

Naphtha	2,500,000	gallons
Illuminating oils	17,000,000	"
Gas oils	38,000	tons
Lubricating oils	40,000	"
Solid paraffin	22,500	"
Ammonium sulphate	50,000	"
Still coke	5,000	"

In 1907, the production of shale amounted to 2,775,799 tons; the average yield of crude oil was 23 gallons per ton. The most important company pays dividends of 50 per cent. on the invested capital; one paid during 1906, 2½ per cent., another, 6 per cent., and the remaining three companies, 15 per cent.

Extensive beds of bituminous shales occur in various localities in New Brunswick and Nova Scotia. Large sums of money have been spent in attempts to establish a mineral-oil industry in these provinces, particularly in connection with the so-called Albert shales of Albert and Westmoreland counties, New Brunswick, but none of these ventures has succeeded in placing the industry on a commercial basis. Encouraged by the success of the industry in Scotland, however, the leading company interested in the oil shales of New Brunswick has had tested in one of the Scotch works a consignment of 45 tons of shale mined during the winter of 1907-8 from one of the bands in Albert County. The tests were made under the supervision of a representative of the Canadian Department of Mines and an exhaustive report, written by Dr. R. W. Ells, has now appeared. The monograph covers not only the results of these trials and the geology and economic possibilities of the oil shales of Eastern Canada, but gives also a comprehensive review of the history and technology of the Scottish oil-shale industry. We are concerned here, however, only with Dr. Ells' conclusions as to the commercial value of the Canadian deposits.

The average yield of the shale tested in Scotland was 40.09 Imperial gallons of crude oil, and 76.94 pounds of sulphate of ammonia, per ton. The yield of both these materials was superior to that of the greater part of the Scottish shales and the behavior of the Canadian material in the retort was entirely satisfactory. Fractioning of the crude oil was done by two methods, the results of which were as follows:

Product.	Method A. Quantites in gallons per 100 gallons of crude oil	Method B. Quantites in gallons per 100 gallons of crude oil
Heavy naphtha	1.62	1.45
Illuminating oils	10.04	11.50
Gas oil	14.87	13.04
Cleaning oil	2.83	1.56
Lubricating oil	9.58	11.03
Crude wax	2.26	2.21
" "	0.93	0.60
" "	....	0.16
Residuum from blue oil (refined)	0.28	0.57
Residuum from treated crude distillate (refined)	1.27	1.95
	43.68	47.07

Analyses of shales from various localities in New Brunswick show contents varying from 30 Imperial gallons of crude oil and 75 pounds of ammonium sulphate, to 54 gallons of crude oil and 110 pounds of ammonium sulphate, per ton. At prevailing prices the values of these products in the shales analyzed vary from $3.04 to $4.81 per ton. The value of the crude oil and ammonium sulphate in the shale tested in Scotland in 1908 would be $3.43 per ton. The cost of mining, retorting and manufacturing the ammonium sulphate averages in Scotch practice about $1.86 per ton. The cost of a complete plant of 180 retorts, with a capacity of 700 to 750 tons per day, is estimated at about $400,000. It appears from these data that the possibilities of profitable exploitation are very promising. Dr. Ells believes, however, that the production of only crude oil and ammonium sulphate should be attempted. "It is doubtful," he says, "if at the present time an expensive plant for the manufacture of refined oils, paraffins, naphthas, etc., on a large scale, would, in the face of possible competition and hostility on the part of the Standard Oil Company, be sufficiently profitable to warrant the necessary expenditure of capital in this part of the proposed enterprise."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING.

BRIDGES.

Arches.

The Elastic Arch. Dean Galbraith. Deals with the theory of the graphical method commonly used in connection with the design and computation of the elastic arch, 2800 w. Ap Sci—March, 1910. No. 13212 C.

The Calculation of Arches (Berechnung von eingespannten Gewölben). A. Burghardt. Mathematical discussion of methods of stress determination. Ills. 2500 w. Beton u Eisen—March 14, 1910. No. 13504 F.

Bascule.

Electrical Operation of Eight-Track Lift Bridge. Illustrated description of a bridge nearing completion over the Chicago Drainage Canal, at 31st St., Chicago. 1500 w. Elec Wld—April 14, 1910. No. 13094.

We supply copies of these articles. See page 479.

Boston.

The Charles River Bridges. Charles W. Killam. A critical discussion of the structures now crossing this river, the need of replacing some of them, and the importance of considering beauty in the designs. Ills. 2000 w. Harvard Engng Jour—April, 1910. No. 13547 D.

Clearances.

Bridges Over Navigable Streams. The Interference of Water Traffic with Land Traffic. Editorial comment, and review of the situation at Pittsburg, with letter from Edwin K. Morris. 3000 w. Eng News—April 14, 1910. No. 13105.

Concrete.

An Analysis of Concrete Bridge Failures. C. R. Young. Read before the Can. Cement & Concrete Assn. Gives information collected in regard to such failures, with a view to determining the suitability of concrete for strong and enduring engineering works. Ills. 4000 w. Engng-Con—April 13, 1910. No. 13088.

Failures.

The Failure of the Pugh Ford Arch Bridge. Correspondence relating to the reinforced-concrete arch highway bridge in Indiana which was wrecked by the erosion of foundations. 3000 w. Eng News—April 21, 1910. No. 13263.

See also Concrete, under BRIDGES.

Floors.

See Reconstruction, under BRIDGES.

Masonry.

A Fine Long-Span Masonry Arch Bridge. Illustrated description of a structure in France, having a main span of 262 ft. 9½ ins., with the keystone about 217 ft. above the level of the water. Also the methods of erection. 900 w. Sci Am—April 9, 1910. No. 12981.

Piers.

Pneumatic Caisson Piers in Alaska. Illustrates and describes work carried out under very unusual and extremely difficult conditions in connection with railway construction. 3500 w. Eng Rec—April 23, 1910. No. 13427.

The Passyunk Avenue Bridge Piers. Illustrated description of the construction of the piers for a highway bridge across the Schuylkill River, at Philadelphia. It is a steel superstructure resting on 11 piers and one abutment. 2500 w. Eng Rec—April 2, 1910. No. 12829.

Piers of the Penhorn Creek Railroad Viaduct. Illustration and description of work on the Erie R. R., at Jersey City, where deep foundations in wet soil were required. 1500 w. Eng Rec—April 2, 1910. No. 12834.

Substructure of a Bridge Over the Zijl Near Leiderdorp on Holland Electric Railway (De Onderbouw eener Brug over de Zijl nabij Leiderdorp in den Hollandschen Elektrischen Spoorweg). J. W. Maas. Illustrated description of the foundations and their construction 2000 w. De Ingenieur—March 12, 1910. No. 13523 D.

Reconstruction.

Report on the Question of the Strengthening of Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains (Subject II, Littera B, for Discussion at the Eighth Session of the Railway Congress). Mr. Labes. Considers the suitable strengthening of existing metal bridges proportionately to the increase in weight of the locomotives and in the speed of the trains. Ills. 21000 w. Bul Int Ry Cong—Jan., 1910. No. 13603 G.

Widening Piney Creek Bridge, Washington. Illustrated description of the construction of a duplicate of a previously completed bridge, and connecting the two with a reinforced concrete platform making a wide roadway. 1500 w. Eng Rec—April 2, 1910. No. 12850.

Widening the Floor of a Double-Track Masonry Viaduct. Brief illustrated description of work on St. Florent viaduct, Paris & Orleans Ry. (France), and the addition of a third track. 900 w. Eng News—April 14, 1910. No. 13103.

Reinforced Concrete.

Building a Concrete Bridge from an Existing Structure. Illustrated description of work at Bethlehem, Pa., replacing a steel bridge with a reinforced-concrete arch bridge. 1800 w. Eng Rec—April 23, 1910. No. 13428.

A Concrete Girder Bridge with Curved Bottom Chord. Illustrates and describes a reinforced-concrete bridge soon to be built at Ocean City, N. J. 1200 w. Eng Rec—April 9, 1910. No. 12986.

The East Olive Avenue Bridge in Spokane, Wash. Illustrated description of the construction of a 5-span reinforced concrete bridge, 565 ft. long, over the Spokane River. 2500 w. Eng Rec—April 2, 1910. No. 12838.

Erection of Florida East Coast Railway Bridges. Describes the location and conditions, the methods adopted, and the damage by a hurricane which caused the canceling of the contract. Ills. 2000 w. Eng Rec—April 2, 1910. No. 12832.

Steel.

Erection of the Slatington Bridge. A new bridge of 14 deck plate girder spans on the Lehigh & New England Ry., in Pennsylvania, is illustrated and described. 2500 w. Eng Rec—April 2, 1910. No. 12854.

Steel Railway and Highway Bridges of the Province of Alberta. J. C. Chalmers. Abridged from a paper read before the Edmonton Engng. Soc. Illustrates and describes types of steel bridges and their substructures. 5400 w. Can Engr—April 1, 1910. No. 12906.

A Steel Arch Bridge in the Province of Yun Nan, French China. Illustrated description of the design and erection of

We supply copies of these articles. See page 479.

bridges in a rugged country, where the work must be done by poor labor. Translated from *Le Génie Civil*. 1200 w. Eng News—April 21, 1910. No. 13259.

The Vistule Steel Viaduct (Le Viaduc métallique sur la Vistule à Marienwerder, Prusse orientale). Illustrated description of a steel structure, 1058 metres long, at Marienwerder, eastern Prussia. 3000 w. Génie Civil—March 5, 1910. No. 13335 D.

Swing Bridges.

Experiments on a Test Pivot for the Caronte Swing Bridge (Expériences sur le Pivot d'Essai du Pont tournant sur l'Etang de Caronte). E. Chartiée and G. Blot. Reports results of experiments made in designing the pivot of a swing bridge of very heavy weight. Ills. 12000 w. Rev Gen d Chemins de Fer—March, 1910. No. 13321 G.

Trestles.

A Five-Mile Trestle Across Albemarle Sound, Norfolk & Southern Ry. Illustrated detailed description of the location, design, construction and operation of this notable timber structure. 1200 w. Eng News—April 21, 1910. No. 13255.

Viaducts.

Different Methods of Erecting Steel Viaducts. Frank W. Skinner. Illustrated detailed description of work of this character as carried out in various places in the United States and Canada. 1600 w. Eng Rec—April 2, 1910. No. 12843.

The Erection of Tinkers Creek Viaduct. Illustrates and describes the erection of a double-track plate-girder structure about 1300 ft. long and 161 ft. high from tops of piers to base of rail, on the

The Construction of the Fades Viaduct (Note sur la Construction du Viaduc des Fades). M. Virard. Detailed description of the erection of a steel structure 470 metres long. Ills. 24000 w. Ann d Ponts et Chaussées—1910-I. No. 13306 E + F.

L. Erie & Pittsburg Ry. 2000 w. Eng Rec—April 2, 1910. No. 12828.

CONSTRUCTION.

Beams.

The Strength of Beams of Channel Section (Versuche über die tatsächliche Widerstandsfähigkeit von Trägern mit [- förmigem Querschnitt). C. Bach. A report of tests. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—March 5, 1910. No. 13509 D.

Boring.

Core Drilling Under the Hudson River for the Catskill Aqueduct. William E. Swift. Describes the methods of vertical drilling from scows anchored in the river, the sinking of a test shaft, and work as finally carried on. 2000 w. Eng News—April 7, 1910. No. 13003.

Columns.

The Design of Columns with Two Parts of Different Section (Sul Calcolo dei Pilastri formati da due Tronchi di diversa Sezione). A. Danusso. Mathematical. Ills. 3000 w. Il Cemento—March 15, 1910. No. 13351 D

Concrete.

A Craftsman's Concrete House at Glencoe, Ill. Illustrated description of the design and construction. 2500 w. Cement Age—April, 1910. No. 13434.

Concrete Building Construction of Separately Molded Members and Its Cost. Extracts from a paper by Charles D. Watson read before the Nat. Assn. of Cement Users. Information concerning buildings constructed of unit concrete members, and their cost. Ills. 2500 w. Engng-Con—April 6, 1910. No. 12954.

Excavation.

A Giant Excavator. Illustrated description of what is believed to be the largest steam crane excavator in existence. 2000 w. Engr, Lond—April 15, 1910. No. 13472 A.

Hydraulic Excavation in the Pacific Division of the Panama Canal. Gives an outline of conditions and the character of the work, describing preliminary work and the plant for the hydraulic work and its operation. Ills. 3500 w. Eng Rec—April 2, 1910. No. 12826.

See also Rock Removal, under WATERWAYS AND HARBORS.

Floors.

Bulb-Iron Floor in the Moldau Harbor Shed in Hamburg (Die Bulbeisendecke im Neubau des Schuppens am Moldauhafen zu Hamburg). G. Kaufmann. Describes floor construction 11,000 square metres in extent. Ills. Serial. 1st part. 4000 w. Beton u Eisen—March 14, 1910. No. 13503 F.

Foundations.

Prevention and Cure of Weak Foundations. Explains cases of weakness caused by changes in water level due to exposure of wood piling, and recommends the use of concrete or other supports unaffected by changes in water level; and the use of strengthening of weak foundations by the sectional method of underpinning. 2500 w. Cement Age—April, 1910. No. 13432.

Deep Foundation Construction in an Occupied Building. Illustrates and describes methods used in a bank building of New York City, to furnish reliable foundations for a concrete and steel safe-deposit vault. 1000 w. Eng Rec—April 9, 1910. No. 12990.

Deep Pneumatic Foundations for New York Municipal Building. Illustrates and describes foundation work of a building 580 ft. high, located in the plaza at the Manhattan Terminal of the Brooklyn Bridge. 1800 w. Eng Rec—April 2, 1910. No. 12846.

"Compressol" System Foundations in Egypt (Gründungen mittels mechanischer Bodenverdichtungen "System Compres-

sol" in Aegypten). Walther Stross. Describes various examples of foundation piling work on this system in the Nile Delta. Ills. 3200 w. Beton u Eisen—March 14, 1910. No. 13502 F.

Piling.

Concrete Piles. From the report of the Committee on Masonry, presented at the annual meeting of the American Railway Engineering and Maintenance of Way Association. Considers types, their advantages, etc. 2500 w. Eng News—April 7, 1910. No. 13001.

Failure of Wooden Piling Due to Private Agencies and Methods of Prevention. W. Putnam. Read before the Nova Scotia Soc. of Civ. Engrs. Considers the insects and worms that destroy timber and the methods of preventing the ravages. 2000 w. Can Engr—April 22, 1910. No. 13438.

See also Foundations, under CONSTRUCTION.

Pipe Galleries.

See same title, under WATER SUPPLY.

Regulations.

Allowable Stresses in Iron (Die baupolizeilichen Beanspruchungsziffern von Eisen). An editorial discussion of new building regulations in Germany. 2200 w. Stahl u Eisen—March 16, 1910. No. 13359 D.

Reinforced Concrete.

Deflection in Reinforced-Concrete Structures and Its Consequences (Beitrag zur Durchbiegung von Eisenbetonkonstruktionen und Folgerungen hieraus). B. Pollnow. Mathematical. Ills. 4500 w. Beton u Eisen—March 14, 1910. No. 13505 F.

Specifications for Plain and Reinforced Concrete and Steel Reinforcement. Presented with report of the Committee on Masonry at the meeting of the Am. Ry. Engng. & Main. of Way Assn. 3000 w. Eng News—April 14, 1910. No. 13108.

A Storage Building for an Automobile Factory. Illustrated description of a reinforced-concrete warehouse at Buffalo, N. Y. 1500 w. Eng Rec—April 16, 1910. No. 13142.

New Automobile Plant of the D. P. Nichols Company, Boston. E. S. Larned. Illustrated detailed description of a reinforced-concrete building at Cambridge, Mass. 2200 w. Cement Age—April, 1910. No. 13433.

Two Examples of Hospital Construction in Reinforced Concrete (Due Costruzioni Ospitaliere in Cemento armato). E. Sacerdote. Describes two structures in Rome, Italy. Ills. 2000 w. Ann d Soc d Ing e d Arch Ital—March 1, 1910. No. 13344 F.

See also Stacks, under CONSTRUCTION; Reservoirs, under WATER SUPPLY; and Locks, under WATERWAYS AND HARBORS.

Stacks.

Special Forms for and Methods of Constructing Weber Concrete Chimneys. Carl Weber. Rearranged from paper before the Am. Soc. of Engng.-Con. Illustrated description of construction methods. 2500 w. Engng-Con—April 20, 1910. No. 13401.

Steel.

The Design of a Plate Girder. Martin Joachimson. An explanation by solving a stated problem. Supplement. 2500 w. Mach, N Y—April, 1910. No. 12898 C.

Stress Variation on the Section of an Angle in Tension. Charles J. Tilden. An account of an experimental study of stress distribution in angles under tension. Ills. 2000 w. Harvard Engng Jour—April, 1910. No. 13548 D.

Steel-Frame Buildings at Gary, Indiana. Illustrates and describes some details of the large steel-frame industrial buildings of the new plant of the Indiana Steel Co. 2000 w. Eng Rec—April 9, 1910. No. 12988.

Erection of Steel Frame Buildings at Gary, Ind. Illustrates and describes methods of construction for unusually large buildings. 1800 w. Eng Rec—April 23, 1910. No. 13422.

Improving the Seventh Regiment Armory, New York. Describes extensions and rearrangements amounting almost to reconstruction, at an estimated cost of about $200,000. 3000 w. Eng Rec—April 2, 1910. No. 12839.

Forest Hills Terminal, Boston Elevated Railway. Illustrated description of a station designed with special considerations to harmonious relations with the surroundings. The steel framework is covered by a reinforced-concrete shell. 1600 w. Eng Rec—April 9, 1910. No. 12989.

Tunnel Lining.

Tunnel Lining, Chicago, Milwaukee & Puget Sound Railway. Illustrates and describes methods used in lining tunnels driven through rotten granite formations. 2000 w. Eng Rec—April 2, 1910. No. 12831.

Tunnels.

Tunnels in Being and Tunnels to Come. Discusses the length, elevation, cost, etc., of famous mountain tunnels. 1200 w. Sci Am Sup—April 23, 1910. No. 13270.

Some Features of the Alignment Work on the Pennsylvania Tunnels. Francis Mason. Outlines the more important methods adopted on the East River Division. Ills. 4000 w. Harvard Engng Jour—April, 1910. No. 13549 D.

Some Engineering Features of the Detroit River Tunnel. Gives an outline of the scheme and illustrates and describes the interesting features of engineering that developed in carrying it to completion. 4000 w. Ry Age Gaz—April 29, 1910. No. 13598.

We supply copies of these articles. See page 479.

Method of Reconstructing the Washington Street Tunnel of the Chicago Railways Company; a New and Economical Method of Constructing Tunnels. Illustrates and describes the reconstruction. 2500 w. Engng-Con—April 20, 1910. No. 13402.

Section 1 of the Washington Street Tunnel, Chicago. Illustrated description of underpinning and invert construction made necessary by the deepening of the Chicago River, under which this street railway tunnel passes. The conditions are very difficult. 2500 w. Eng Rec—April 2, 1910. No. 12835.

The Wallkill Pressure Tunnel of the Catskill Aqueduct. Illustrates and describes the construction of the Wallkill siphon, a part of the distribution system of the Catskill water supply. It is a circular concrete lined tunnel 23,391 ft. long and 14 ft. 6 in. inside diameter, with 6 shafts ranging in depth from 350 to 480 ft. 6000 w. Eng Rec—April 2, 1910. No. 12847.

The Laramie Tunnel. R. L. Herrick. Brief illustrated description of the methods of construction, and matters of related interest. 1800 w. Mines & Min—April, 1910. No. 12865 C.

The Hunters Brook Tunnel Construction. Describes the construction plant and work on this horse-shoe shape tunnel of the N. Y. water supply. 3000 w. Eng Rec—April 2, 1910. No. 12848.

Warehouses.

Warehouses. Charles H. Patton. An illustrated discussion of their planning and construction. 3500 w. Archt Rec—April, 1910. No. 13069 C.

MATERIALS OF CONSTRUCTION.

Cement Tile.

Some Experiments on the Cost and Durability of Cement Drain Tile. W. H. Day. Read before the Can. Cement & Concrete Assn. Reports mine experiments and the results. 2500 w. Engng-Con—April 13, 1910. No. 13087.

Concrete.

The Action of Frost on Hydraulic Cements — Concreting During Freezing Weather. Alfred E. Uren. An outline of investigations made in this field. 3000 w. Ap Sci—March, 1910. No. 13217 C.

Reinforced Concrete.

Eleventh International Navigation Congress, St. Petersburg, 1908 (XIe Congrès international de Navigation tenu à Saint-Pétersbourg en 1908). A report of the discussion on the application of reinforced concrete to the construction of marine works. Ills. 25000 w. Ann d Ponts et Chaussées—1910-I. No. 13309 E + F.

Stone.

The Physical Properties of Building Material. William Ralph Baldwin Wiseman and Owen Williams Griffith. A report of experimental investigations, with conclusions. 5600 w. Inst of Civ Engrs—No. 3856. No. 13273 N.

Structural Materials.

Present-Day Needs in Structural Materials. Discussion of the needs in Road Materials, by S. D. Foster; in Refractory Materials, by Kenneth Seaver; Fire Proofing Problems, by C. B. Asher; Timber, by E. F. Wendt; Steel, by R. B. Wordworth and others. Ills. 15500 w. Pro Engrs' Soc of W Penn—April, 1910. No. 13431 D.

Timber Preservation.

Preservatives for Wood Paving Blocks. Charles N. Forrest. Data and information concerning the adoption of tar in lieu of creosote oil. 1500 w. Eng Rec—April 16, 1910. No. 13140.

MEASUREMENT.

Cement Testing.

Notes on the Le Chatelier Boiling Test of Portland Cement. D. B. Butler. Abstract of a paper read before the Concrete Inst. 1800 w. Surveyor—March 25, 1910. No. 12928 A.

Hydrographic Surveying.

The Mille Lac Lake Survey, Minnesota; Methods and Costs. Robert Follansbee. An account of a survey made in connection with an investigation of the state's water resources. 1000 w. Eng News—April 7, 1910. No. 12998.

Stream Gauging.

A Comparison of Stream Discharge Indicated by Current Meter and by Weir Formulas, Yakima River, Washington. J. C. Stevens. Gives interesting comparison of results secured with a current meter and those obtained by a formula for an overflow dam. Ills. 700 w. Eng News—April 28, 1910. No. 13567.

River Gauging with Rod Floats. George W. Brown. Details of a method of stream gauging by use of rod floats, with an outline of the reductions. 2500 w. Wis Engr— April, 1910. No. 13200 D.

Surveying.

History of the Ordnance Survey. J. J. Amos. Describes methods used in work carried out by the British Government. 4500 w. Surveyor—March 25, 1910. No. 12927 A.

Tests of Simple and Inexpensive Surveying Instruments. John T. Stewart. Abstract of paper read before the Ill. Soc. of Engrs. & Surv. A report of experiments carried out to determine the value of such instruments. 2500 w. Eng News—April 21, 1910. No. 13257.

The Stadia and Stadia Surveying. E. M. Douglas. Suggestions for careful stadia work, explaining the usefulness of this device. 3500 w. Eng News—April 28, 1910. No. 13569.

Plotting Co-ordinate Surveys. J. J. Bristol. Describes graduated triangles for

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plotting co-ordinates, explaining their use. 1500 w. Min & Sci Pr—April 2, 1910. Serial. 1st part. No. 12969.

MUNICIPAL.

City Planning.

The Planning of Towns and Suburbs. Raymond Unwin. An illustrated study of the principles governing the planning and arrangement. 4500 w. Jour Roy Inst of Brit Archts—March 5, 1910. No. 12918 B.

Market Buildings.

Municipal Markets of St. Louis. Charles Claude Casey. Illustrates and describes structural features, sanitation and refrigeration, etc. 3500 w. Munic Jour & Engr—April 27, 1910. No. 13489.

Pavements.

Average Unit Prices and Some Details of Pavements Constructed in 1909 in a Number of Representative American Cities. 3000 w. Engng-Con—April 6, 1910. No. 12955.

Specifications for Bituminous Concrete Pavement. Report of committee of the Organization for Standardizing Pavement Specifications. 2000 w. Munic Engng—April, 1910. No. 13222 C.

Specifications for Concrete Sidewalks, Curbs and Gutters and Pavements. Report of committee of the Organization for Standardizing Paving Specifications. 1500 w. Munic Engng—April, 1910. No. 13223 C.

Specifications for Sheet Asphalt Pavement. Report of the asphalt committee of the Organization for Standardizing Paving Specifications. 2500 w. Munic Engng—April, 1910. No. 13221 C.

Tramway Margins. J. S. Killick. The difficulties in the maintenance of tramway margins, particularly the joint between a paved track and a macadam road, are discussed. 1500 w. Surveyor—April 15, 1910. No. 13448 A.

See also Timber Preservation, under MATERIALS OF CONSTRUCTION; and Streets, under MUNICIPAL.

Public Baths.

New Public Baths at Hinckley. Illustrates and describes details of construction. 900 w. Surveyor—April 1, 1910. No. 13049 A.

Refuse Disposal.

Town Scavenging and Refuse Disposal. Hugh S. Watson. Discusses the usual methods of disposal of house refuse. 2500 w. Munic Engng—April, 1910. No. 13220 C.

High Temperature Garbage and Refuse Destructors. Col. W. F. Morse. Read before the Am. Soc. of Munic. Imp. Presents the advantages of the destructor system as compared with the crematory system. 3000 w. Munic Engng—April, 1910. No. 13227 C.

Roads.

Public Roads and Vicinal Railways. R. O. Wynne-Roberts. Shows how railways on public roads promote the development of rural districts and assist in road improvements. 6000 w. Surveyor—April 15, 1910. No. 13451 A.

Sand-Clay and Earth Roads in the Middle West. W. L. Spoon. Information concerning the methods and experimenal roads constructed by the Office of Public Roads. Discusses the soil conditions in different localities, describing the road improvement applicable to each. Ills. 9500 w. U S Dept of Agri, Circ. No. 91—March 19, 1910. No. 12957 N.

Sand-Clay Roads in the Middle West. Extracts from a circular by W. L. Spoon, giving an account of materials and methods of construction. 3000 w. Eng Rec—April 16, 1910. No. 13136.

Report on the First International Road Congress. P. C. Cowan. Report to the Local Government Board of Ireland 3500 w. Surveyor—April 15, 1910. Serial. 1st part. No. 13452 A.

Irish Roads. Answers from county surveyors, to questions relating to construction, maintenance and administration. 4000 w. Surveyor—April 15, 1910. Serial. 1st part. No. 13453 A.

Modern Conditions Affecting the Road Engineer. W. H. Maxwell. Discusses the increase and change in character of the traffic, and the problems due to it. 2500 w. Surveyor—April 15, 1910. No. 13450 A.

Roads and Vehicles. Col. R. E. Crompton. Discusses the future of road engineering, the construction, maintenance and improvements in wheel construction. 2200 w. Surveyor—April 15, 1910. No. 13446 A.

The Other Half of the Automobile. Discusses the importance of the roadbed upon car performance, the damage to roads by automobiles, and the improvements needed. Ills. 1800 w. Automobile—April 21, 1910. No. 13292.

Modern Road Repairs. E. Purnell Hooley. Compares the wearing qualities of waterbound and waterproof roads, and considers in detail the construction of a Tarmac road. 2000 w. Surveyor—April 15, 1910. No. 13447 A.

Best Means of Dustproofing the Highway. Marius C. Krarup. A review of present information on this subject, concluding that the problem is not yet satisfactorily solved. 2000 w. Automobile—April 28, 1910. Serial. 1st part. No. 13579.

Experimental Work of the New York State Highway Commission in 1909 with Glutrin, and with Resurfacing with Bituminous Macadam and Asphalt Macadam. Notes from recent report of the N. Y. State Highway Commission describing the experimental work carried out. 4000 w. Engng-Con—April 13, 1910. No. 13089.

Methods of a New York State Commission of Highways in Testing Bitumi-

nous Materials Used in Road Work. Also Road Surface Treatment with Oil in 1909. 3000 w. Engng-Con—April 27, 1910. No. 13556.

The Use of Tar on Roads. W. J. Atkinson Butterfield. Deals with the properties of tars as regards their suitability for road work. 2000 w. Surveyor—April 15, 1910. No. 13445 A.

Tar-Macadam Roads. F. E. Newberry. Read at meeting of the Illinois Gas Assn. Argument favoring tar-macadam and showing its advantage in cost and durability. Ills. 3000 w. Pro Age—April 1, 1910. No. 12810.

Tar Treatment of Roads. P. P. Sharples. Read at meeting of the Illinois Gas Assn. Outlines the modern use of tar in treatment of roads. Discussion. 3500 w. Pro Age—April 1, 1910. No. 12811.

Tar as Applied to the Surface Treatment of Roads. Harvey J. Skinner. Read at meeting of the Am. Gas Inst. Discusses the wear of roads due to change in traffic, the methods of applying tar and matters related. Discussion. 6000 w. Pro Age—April 1, 1910. No. 12812.

Asphaltic Oil Treatment of Macadam Roads. Charles H. Bartlett. Discusses methods and quality of oil, for the preservation of road surfaces, and elimination of dust. 4000 w. Jour Assn of Engng Socs—Feb., 1910. No. 12963 C.

Sewage Disposal.

Sewage and Sewage Effluents. John C. Thresh. Lecture before the Assn. of Mgrs. of Sewage Disposal Works. Interpretation of the results of analyses. 3500 w. Surveyor—April 1, 1910. Serial. 1st part. No. 13050 A.

Notes on the Proposed Sewage Disposal Plant for Gloversville, N. Y. Morrell Vrooman. Outlines the nature, dimensions, and capacity of the various parts of the plant and the proposed method of operation. The sewage contains a large amount of tannery wastes. 1000 w. Eng News—April 28, 1910. No. 13568.

The Sewage Disposal Plant at Roebling. Outlines the conditions, and describes in detail the systems of sewerage and the methods of disposal. Ills. 4000 w. Eng Rec—April 9, 1910. No. 12985.

New Sewage Pumping Station at Glasgow. Illustrated description of the station at Kinning Park, Glasgow, in connection with the purification of the river Clyde. 2000 w. Engr, Lond—April 8, 1910. No. 13170.

Mechanical Sewage Purification Plants (Maschinelle Abwasser-Reinigungs-Anlagen). Herr Wurl. Describes a number of plants in Germany. Ills. 7000 w. Glasers Ann—March 15, 1910. No. 13396 D.

Sewer Cleaning.

Sewer Cleaning in Brooklyn. Describes the methods adopted. 1000 w. Eng Rec—April 2, 1910. No. 12855.

Sewers.

Constructing Concrete Sewers in Open Trench. Describes work in progress on Staten Island. Ills. 1500 w. Eng Rec—April 16, 1910. No. 13135.

Constructing a Large Brick-Lined Sewer Tunnel, Brooklyn, N. Y. Illustrated detailed description of the construction of a sewer having an internal diameter of 138 inches. 3000 w. Eng Rec—April 9, 1910. No. 12987.

Cost of Sewer, Muskoka, Ont. E. A. James. Gives details of a sewer having 550 ft. in granite rock, 9 ft. deep. 500 w. Ap Sci—March, 1910. No. 13215 C.

Construction Methods on the Louisville Sewerage Work. Illustrated description of methods used on extensive sewerage improvements. 2800 w. Eng Rec—April 2, 1910. No. 12851.

The Southern Outfall Sewer, Louisville, Ky. William Mayo Venable. Illustrated description of the largest trunk sewer of the extensive system under construction. It is of reinforced concrete. 1200 w. Eng Rec—April 2, 1910. No. 12852.

Intercepting Sewer at Elizabeth, N. J. Illustrated description of a sewer to prevent the pollution of Elizabeth River. Siphon river crossings, coffer dam construction, methods of excavating, etc., are described. 3000 w. Munic Jour & Engr—April 6, 1910. No. 12917.

Sidewalks.

See Pavements, under MUNICIPAL.

Stone Crushing.

New Crushing Plants of the Casparis Stone Company. Illustrates and describes the two largest crushing plants yet designed, located at Havre de Grace, Md., and Patterson Creek, W. Va. 2000 w. Eng Rec—April 2, 1910. No. 12845.

Street Cleaning.

Tests of Street Flushing or Washing Machines, Department of Street Cleaning, New York City. E. D. Very. Describes flushing tests made, giving summary of tests of six machines. 1500 w. Eng News—April 14, 1910. No. 13099.

Streets.

The Dimensions of Roads and Streets. H. Percy Boulnois. Discusses relative widths of footways and roadways. 2500 w. Surveyor—April 15, 1910. No. 13444.

WATER SUPPLY.

Aqueducts.

See Tunnels, under CONSTRUCTION.

Artesian.

See Wells, under WATER SUPPLY.

Baltimore, Md.

A Proposed Enlargement of the Water-Supply of Baltimore, Md. Alfred M. Quick. Reviews the general features of the present supply system and gives the general conclusions and recommendations of the consulting engineers. 2200 w. Eng News—April 21, 1910. No. 13264.

Dams.

Failure of an Earth Dam with Concrete Core Wall, at Erindale, Ontario. Francis F. Longley. An illustrated account of a dam that failed during construction. 1000 w. Eng News—April 14, 1910. No. 13106.

Construction of the Belle Fourche Dam. O. T. Ready. Illustrated description of the construction of a dam in South Dakota, to store the flood waters for use in irrigation. 4500 w. Eng Rec—April 2, 1910. No. 12853.

The Hume Lake Multiple Arch Dam. Gives the principles of design and methods of construction of a type of masonry dam new to the United States. It is on Ten Mile Creek, California, and was recently completed. Ills. 7000 w. Cal Jour of Tech—March, 1910. No. 13073.

The Salmon River Dam and Irrigation Project, Idaho. Illustrated detailed description of the construction of a dam to develop the reservoir site. It crosses a deep narrow canyon worn through the rock by the river. The equipment for the work is also described. 5500 w. Eng Rec—April 2, 1910. No. 12840.

Designs and Contract for Rebuilding the Colorado River Dam at Austin, Texas. Reviews the previous history of this dam, and gives a summary of the terms of the contract for its rebuilding. Ills. 3000 w. Eng News—April 14, 1910. No. 13107.

The St. Andrew's Rapid Dam (Das Wehr in den St. Andrews-Stromschnellen). H. P. Borden. Describes the construction of this important work in Manitoba. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—March 12, 1910. No. 13510 D.

Disinfection.

The Growing Use of Hypochlorites of Sodium and Calcium as Water Disinfectants. Editorial, and six articles by George Reyer, J. A. Jensen, W. R. Gelston, Ermon M. Peck, and others. Ills. 12500 w. Eng News—April 7, 1910. No. 12999.

Filtration.

Sand Filters and Disease Germs. Rudolph Hering. Discusses the passage of pathogenic bacteria through sand filters. 2000 w. Munic Jour & Engr—April 27, 1910. No. 13490.

The Cleansing of Filtering Media. A. B. Ogden. Read before the Inst. of San. Engrs. Considers the cleansing of media which has been used in filtration, and the cost. 2000 w. Surveyor—April 8, 1910. No. 13160 A.

The Slow Sand Water Filters under Construction at Reading, Pa. Mandes Golder. Plan and illustrated description of the Maiden Creek slow sand water filters now under construction. 3000 w. Eng News—April 14, 1910. No. 13100.

Reading Water Works Improvements. Illustrates and describes interesting filter and reservoir construction. 4000 w. Munic Jour & Engr—April 20, 1910. No. 13204.

A 10,000,000-Gal. Pressure Mechanical Water Filtration Plant at Duke's Farm, Somerville, N. J. George F. Hodkinson. Plan and description of a large filtration plant for purifying the water of Raritan River, for the supply of a beautiful country estate having many lakes, fountains, etc. 1500 w. Eng News—April 14, 1910. No. 13101.

Ground Waters.

See Water Works, under WATER SUPPLY.

India.

Water Supply in India. Percy G. Scott. Describes Moulmein, Burma, scheme and method of carrying out work in a tropical country. 3000 w. Surveyor—April 8, 1910. No. 13159 A.

Irrigation.

Irrigation and Engineering. D. A. Willey. An illustrated account of work of the United States Reclamation Service. 6500 w. Cassier's Mag—April, 1910. No. 13189 B.

Irrigation Legislation for the Philippine Islands. A. E. Chandler. An account of conditions, the legislation for the use and distribution of water formerly enacted, and that needed. 3500 w. Cal Jour of Tech—March, 1910. No. 13072.

Government Irrigation in the Yakima Watershed.—The Tieton Canyon Canal. Day Allen Willey. Brief illustrated description of the Tieton project, and the difficulties encountered. 1000 w. Sci Am—April 16, 1910. No. 13110.

Sun River Project, Montana; United States Reclamation Service. S. B. Robbins. Information concerning this project, the irrigation contemplated, cost, etc. 1500 w. Jour Assn of Engng Socs—Feb., 1910. No. 12964 C.

Concrete Chute in an Irrigation Canal. M. Nikolitch. Brief illustrated description of a chute and other canal works in the Imperial Valley. 1000 w. Eng Rec—April 23, 1910. No. 13426.

See also Electric Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Minnesota.

Water Resources Investigation in Minnesota. Robert Follansbee. Describes the work of investigating the water resources of this state. 3000 w. Cornell Civ Engr—April, 1910. No. 13546 C.

Ozone Treatment.

See Purification, under WATER SUPPLY.

Pipe Galleries.

New York City Pipe Galleries. Walter G. Turini. Brief illustrated description of the first pipe galleries built in the city, and the method of construction. 900 w. Munic Jour & Engr—April 13, 1910. No. 13079.

We supply copies of these articles. See page 479.

Pollution.

The Chances of Pollution in Shallow Wells for Municipal Water Supply. Charles B. Burdick. Abstract of paper before the Ill. Water Supply Assn. Notes on the sanitary character of well-water, referring particularly to shallow wells deriving their supply from sands and gravels. 2000 w. Eng News—April 21, 1910. No. 13266.

See also Construction Camps, under MISCELLANY.

Purification.

The Coagulating Plant of the St. Louis Water Works. Arthur J. Jacobs. Describes a plant where the process is strictly one of coagulation and sedimentation, no filters being used. 11800 w. Jour Assn of Engng Socs—March, 1910. No. 13528 C.

Water Purification and Pumping Plant at New Orleans, La. Illustrated detailed account of works put in operation about one year ago, for purifying the Mississippi River water before distributing. 6000 w. Eng Rec—April 23, 1910. No. 13421.

Drinking-Water Supply for Dwellings in Isolated Places. (Drinkwatervoorziening in het klein, voor Woningen ap afgelegen Orden). H. van Berckel. Describes devices for water purification on a small scale. Ills. 3500 w. De Ingenieur—March 19, 1910. No. 13524 D.

The Production and Utilization of Ozone with Especial Reference to Water Purification. Describes the development of various processes for the use of ozone as a disinfecting and bleaching agent, especially for purifying city water supplies. Also editorial. Ills. 13500 w. Eng News—April 28, 1910. No. 13572.

Ozone Sterilization of Water. Clifford D. Meeker. Explains the different forms of apparatus used, principles of action, effects of temperature and humidity and cost. Ills. 5000 w. Munic Jour & Engr—April 20, 1910. No. 13205.

Reservoirs.

Failure of a Reinforced Concrete Reservoir. Gives data regarding the failure of a service reservoir at Mittagong, N. S. W., taken from the report for 1909 of the Dept. of Pub. Works, N. S. W. 1500 w. Eng Rec—April 23, 1910. No. 13425.

An Earth Reservoir at Ogden, Utah. Illustrated description of a 13,000,000-gal. reservoir recently completed for the municipal water-supply system. 1500 w. Eng Rec—April 16, 1910. No. 13137.

The Construction of a Reinforced Concrete Reservoir of One Million Gallons Capacity. H. F. Blomquist. Brief illustrated description of a structure for the city of New Ulm, Minn. 1200 w. Minn Engr—March, 1910. No. 13077 C.

See also Filtration, under WATER SUPPLY.

Sterilization.

Germicidal Effect of Mine Water and Tannery Wastes. A report of experimental investigations to determine their effect on certain micro-organisms. 2000 w. Eng Rec—April 16, 1910. No. 13141.

Surface Waters.

The Quality of Surface Waters in the United States. R. B. Dole. First of a number of reports on exhaustive analyses made to determine the quality. Gives the methods of analysis and the results. Of value to railroad engineers and industrial plants. 25000 w. U S Geol Surv—Paper 236. (1909). No. 13068 N.

Tunnel Intakes.

A Novel Method of Placing Cast Iron Wells in a Water Works Crib. Illustrates and describes methods adopted in the permanent crib in Lake Michigan, for the Chicago water-works. 3000 w. Engng-Con—April 13, 1910. No. 13090.

Typhoid.

A Classification and Study of the Typhoid Statistics of the Cities of the United States. George Rodney Taylor. Statistics of interest in connection with pure water supply. 4000 w. Eng News—April 21, 1910. No. 13254.

Water Towers.

Two Water Towers at Leiden (De tweede Watertoren van de Leidsche Duinwater-Maatschappij aan den Hoogen Rijndijk te Leiden). W. C. Van Manen. Illustrated description. 2200 w. De Ingenieur—March 5, 1910. No. 13522 D.

Water Works.

The Matzendorf Water Works of the Vienna Water-Supply System (Das Wasserwerk der Stadt Wien in Matzendorf). Alexander Swetz. Describes a plant for the development of a ground-water supply. Ills. 8000 w. Zeitschr d Oest Ing u Arch Ver—March 18, 1910. No. 13398 D.

The Coulouvrenière Plant and the Water-Works System of Geneva and Vicinity (Notice sur l'Usine de la Coulouvrenière et le Service des Eaux de la Ville de Genève et des Environs). M. Vagneux. Describes a system supplying water at low pressure for domestic purposes, and at high pressure for motive power. 2500 w. Ann d Ponts et Chaussées—1910-I. No. 13310 E + F.

Wells.

Lowering Water Level in Wells of Frankfort, Ind. J. B. Marvin. An account of the trouble, and of a growth of algae believed to be due to the use of compressed air. 1000 w. Munic Engng—April, 1910. No. 13226 C.

The Artesian Wells of the Water Supply of Memphis, Tenn. An account of an unusual system of supply. 1500 w. Munic Engng—April, 1910. No. 13225 C.

See also Pollution, under WATER SUPPLY.

We supply copies of these articles. See page 479.

WATERWAYS AND HARBORS.

Barge Canal.

The Construction of the New York State Barge Canal. Data from the annual report of Frank M. Williams showing the present condition of this great engineering work, with illustrated descriptions of recent work on various contracts. 12500 w. Eng Rec—April 2, 1910. No. 12841.

Cofferdams.

A Portable Floating Cofferdam. Illustrates and describes details of a cofferdam used on the Minidoka project of the U. S. Reclamation Service on the Snake River in Southern Idaho, for setting a number of large, heavy penstock gates and trash racks. 1500 w. Eng Rec—April 2, 1910. No. 12842.

Cumberland River.

Cumberland River Canalization. William W. Harts. Recent work on the canalized portion of the river is illustrated and described and cost records given. 1000 w. Eng Rec—April 16, 1910. No. 13133.

Detroit River.

Progress in the Improvement of the Detroit River. Excavation work to provide a minimum depth of 22 ft. is illustrated and described. 3000 w. Eng Rec—April 2, 1910. No. 12830.

Docks.

The New Dock Facilities at Avonmouth, England. Map, plan, and sections, with description of recent improvements carried out at Avonmouth, on the Bristol Channel. 2500 w. Eng News—April 28, 1910. No. 13571.

The New King's Dock at Swansea. C. van Langendonck. Illustrated description of this great dock and its construction. 2000 w. Sci Am Sup—April 2, 1910. No. 12786.

Dover, Eng.

The Port of Dover. Arthur T. Walmisley. Reviews the history of this port. Map. Discussion. 9800 w. Jour Soc of Arts—April 15, 1910. No. 13439 A.

Dry Docks.

The New Dry-Dock of the Toledo Shipbuilding Company. Harry C. McClure. Illustrated description of a concrete dock on the Maumee River, at Toledo, Ohio. 2200 w. Eng Rec—April 2, 1910. No. 12856.

Extension of the Castigneau Dry Dock at the Toulon Arsenal (Note sur les Travaux d'Allongement du Bassin de Castigneau à l'Arsenal de Toulon). M. Maroger. Describes the work of adding 25 metres to the length of the dock. Ills. 7500 w. Ann d Ponts et Chaussées—1910-I. No. 13307 E + F.

Floods.

Floods in the River Seine. Thomas P. Roberts. Remarks on proposed means to mitigate flood conditions at Paris. Discussion. 6000 w. Pro Engrs' Soc of W Penn—March, 1910. No. 13074 D.

The Effects of the Seine Floods in Paris and Vicinity (Les Effets de la Crue de la Seine du 28 Janvier 1910 dans Paris et sa Banlieue). A. Dumas. Illustrated discussion of temporary and permanent effects. 7500 w. Génie Civil—March 26, 1910. No. 13340 D.

Lighthouses.

Unattended Fog Signal and Lighthouse at Guernsey. The lighthouse situated on the isolated rock known as the Platte Fougère, at the entrance to the Little Russel Channel, is illustrated and described, especially the powerful fog signal. 1800 w. Engr, Lond—April 8, 1910. No. 13173 A.

Locks.

Building the Huge Concrete Locks at Gatun, Panama. Illustrated description of special appliances by which locks 400 ft. wide, 4000 ft. long and 90 to 100 ft. deep are constructed. 1600 w. Sci Am—April 2, 1910. No. 12785.

Methods and Cost of Constructing a Concrete Lock on the Illinois and Mississippi Canal. Data relating to the construction of what is known as the Feeder Guard Lock. Ills. 4500 w. Engng-Con—April 27, 1910. No. 13555.

Lock of the Black Rock Harbor Improvement, Buffalo. Government work in the Niagara River is illustrated and described, including a ship lock 122 x 817 ft. in plan. 2500 w. Eng Rec—April 2, 1910. No. 12833.

See also Canal Haulage, under STREET AND ELECTRIC RAILWAYS.

Panama Canal.

The Magnitude of the Operations at Panama. Gives four plates and general information of the methods and equipment for carrying on this great work. 1800 w. Eng Rec—April 23, 1910. No. 13424.

See also Excavation, under CONSTRUCTION; and Locks, under WATERWAYS AND HARBORS.

Pollution.

A Notable British Court Decision Regarding Stream Pollution by the Birmingham Sewage Works. The court employed its own expert to submit evidence, and decided that the effluent discharged was better than the stream that received it. 4000 w. Eng News—April 21, 1910. No. 13260.

Rock Removal.

Rock-Drill Vessel for the Austrian Marine Department at Triest (Felsenbohrschiff für die k. k. Seebehörde in Triest). Carl Stromek. Describes the equipment of a vessel for rock excavation in Triest harbor. Ills. 1500 w. Zeitschr d Ver Deutscher Ing—March 26, 1910. No. 13514 D.

We supply copies of these articles. See page 479.

Seepage Losses.

A Study of Seepage Losses from Streams in Owens Valley, California. Charles H. Lee. Describes Owens Valley, and reports the method of study and the conclusions. Ills. 2500 w. Eng News—April 21, 1910. No. 13253.

Shore Protection.

Revetments Along the Rio Grande. George A. McKay. Remarks on river bank protection, with a description of the scheme used by the Mexican Government along the Rio Grande. 1800 w. Harvard Engng Jour—April, 1910. No. 13550 D.

Soil Erosion.

The Influence of Sand of One Size on the Quantity of Sand of Another Size That a Stream Will Transport. E. C. Murphy. Gives interesting data obtained in a study made by the writer. 900 w. Cornell Civ Engr—April, 1910. No. 13545 C.

Tractive, Propulsive and Erosive Power of River Currents (Einige Untersuchungen über die Schlepp-, Stoss- oder Räumungskraft in Flüssen). Wilhelm Plenkner. A review of investigations. Serial. 1st part. 5000 w. Oest Wochenschr f d Oeffent Baudienst—March 5, 1910. No. 13501 D.

Reproduction in Models of the Phenomena of the Movement of Sands in Rivers and Along the Coast (Riproduzione su Modelli dei Fenomeni di Sabbie mobili nei Fiumi e lungo i Litorali). Mario Majocchi. A review of investigations. Ills. 5000 w. Monit Tech—March 10, 1910. No. 13350 D.

Stream Gauging.

See same title, under MEASUREMENT.

Transfer Bridges.

Oak Point Float Bridge Substructure Construction. Illustrated description of the substructure for the 12 transfer bridges in the improved freight yard of the N. Y., N. H. & H. R. R. in the Bronx, New York. 2500 w. Eng Rec—April 2, 1910. No. 12837.

Water Powers.

Water Power on Our Northern Slope to James Bay, Province of Ontario. L. V. Rorke. Abridged from an address before the Engrs' Club, Toronto. Information in regard to the great amount of water power available. 2200 w. Can Engr—April 15, 1910. No. 13126.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Weir Formulae.

Experiments Upon the Flow of Water Over Triangular Notches. James Barr. An illustrated account of investigations for verifying the formula proposed by Mr. James Thomson. 3000 w. Engng—April 8, 1910. Serial. 1st part. No. 13164 A.

MISCELLANY.

Building Vibrations.

Displacements of the Top of the Eiffel Tower (Les Déplacements quotidiens du Sommet de la Tour Eiffel). E. Bret. Discusses the displacements, amounting in some cases to 24 centimetres, caused by the action of sun and wind. Ills. 3500 w. Génie Civil—March 12, 1910. No. 13337 D.

Construction Camps.

Sanitation in Construction Camps of the Catskill Aqueduct. Plans and illustrated description of measures taken for the careful protection of the watersheds from pollution. 3000 w. Eng Rec—April 2, 1910. No. 12844.

Forestry.

The Influence of Forests on Climate, Floods and Erosion. George F. Swain. Extracts from a discussion of a report by Prof. Willis L. Moore, taken from an advance copy of a contribution to *American Forestry*. 6000 w. Eng News—April 14, 1910. No. 13102.

Indian State Forestry. Saint-Hill Eardley-Wilmot. Information concerning state forestry in India and the chief factors of its success. Discussion. 12500 w. Jour Soc of Arts—April 1, 1910. No. 13032 A.

Peru.

Some Conditions, Methods and Costs of Construction Work, in Peru, South America. Ills. 1800 w. Engng-Con—April 27, 1910. No. 13558.

Wood Refuse.

Alcohol from Wood Waste. Prof. R. F. Ruttan. Read before the Soc. of Chem. Ind. An explanation of its chemistry and processes. 4500 w. Sci Am Sup—April 16, 1910. No. 13111.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Wireless Telegraphy (Telegrafia senza Fili). G. Marconi. An address delivered on the occasion of the presentation of the Nobel prize. Ills. Serial. 1st part. 1800 w. Industria—March 13, 1910. No. 13348 D.

The Employment of the Stone Intermediate Circuit in Radiotelegraphy and Radiotelephony (Sur l'Emploi du Circuit intermédiaire de Stone en Radiotélégraphie et en Radiotéléphonie). M. Bethenod. Mathematical discussion of the use of intermediate circuits. Ills. 5500 w. Bul Soc Int des Elecns—March, 1910. No. 13312 F.

We supply copies of these articles. See page 479.

The Boulogne-sur-Mer Radiotelegraphic Station (Le Poste de Télégraphie sans Fil de Boulogne-sur-Mer). J. A. Montpellier. Description of the Bellini-Tosi system and the Boulogne-sur-Mer station. Ills. 2700 w. L'Elecn—March 19, 1910. No. 13326 D.

Results Obtained at the Radiotelegraphic Station at Boulogne-sur-Mer (Résultats obtenus an Poste radiotélégraphique de Boulogne-sur-Mer). M. Tosi. Results of trials of the Bellini-Tosi system. Ills. 4000 w. Bul Soc Int des Elecns—March, 1910. No. 13313 F.

Radiotelephony.

See Radiotelegraphy, under COMMUNICATION.

Telegraphy.

The Kitsée Cable Relay. Illustrated description of the Kitsée cable telegraph system which permits signals being received by a common sounder. 1200 w. Elec Rev, N Y—April 30, 1910. No. 13622.

Telephony.

Future Telephone Service by Meter. Francis Dagger. Illustrated description of the system of the Telechromometer Co., of Rochester, N. Y. 1200 w. Can Elec News—April, 1910. No. 12857 C.

The Adaptation of the Test Wire to Telephony. Dr. W. Lulofs. Describes an arrangement whereby the test wires on an electrical distribution system can be used simultaneously for telephonic and pressure test purposes. 1500 w. Elect'n, Lond—April 1, 1910. No. 13043 A.

Telharmonium.

Electrical Transmission of Music. Illustrated account of recent developments in the Cahill Telharmonic system. 3500 w. Elec Wld—April 28, 1910. No. 13560.

Submarine Cables.

The Gott-Raymond-Barker Calibrated Curve-Sheet for Jona Graphs. Edward Raymond-Barker. Note for submarine cable staffs in regard to the application of graphic methods to the electrical localization of cable breaks. 1000 w. Elec Rev, Lond—April 8, 1910. No. 13156 A.

DISTRIBUTION.

Fuses.

Some Experience in Fuse Design and Operation. James A. Seager. An account of experiences showing difficulties encountered. 1500 w. Elec Rev, N Y—April 30, 1910. No. 13620.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Automatic Regulation of Alternators. M. Seidner. Abstract of an article in the *Elek. Zeit.* Discusses the possibilities of regulation, and describes types of regulators. 2200 w. Elect'n, Lond—April 5, 1910. Serial. 1st part. No. 13458 A.

Recent Arrangements for the Parallel Operation of Electrical Machinery (Neuere Einrichtungen für den Parallelbetrieb elektrischer Maschinen). Herr Wolf. Describes a number of methods developed by German firms. Ills. 3000 w. Elektrotech u Maschinenbau—March 20 1910. No. 13518 D.

A. C. Motors.

Single-Phase and Polyphase Commutator Motors (Etude des Moteurs alternatifs monophasés et polyphasés à Collecteur). Eugène Perdu. A detailed study of their design, operation, and applications. Ills. Serial. 1st part. 4500 w. Tech Mod—March, 1910. No. 13324 D.

A. C. Turbo-Generators.

Turbo-Alternator Design. H. G. Reist. Illustrated discussion of problems peculiar to this type, because of the high speeds involved. 2200 w. Sib Jour of Engng—April, 1910. No. 13542 C.

D. C. Motors.

Compound Motors. L. Crouch. Considers the differences between the two types as regards characteristics and design, and compares with other types. 1500 w. Prac Engr—April 1, 1910. Serial. 1st part. No. 13047 A.

A 2000 Horsepower Direct Current Motor. J. B. Van Brussel. Illustrates and describes one of the largest d. c. motors yet constructed, with an elaborate system of rheostat control. 1200 w. Power —April 26, 1910. No. 13477.

Depreciation.

See same title, under INDUSTRIAL ECONOMY.

Induction Motors.

The Relation Between the Stator and Rotor Circuits of the Single-Phase Induction Motor. C. F. Smith. Discusses the connection between the current and voltage in the stator and in the rotor, and deduces expressions for use in calculations. 3500 w. Elect'n, Lond—March 25, 1910. No. 12924 A.

Phase Advances.

Westinghouse Phase Advancer. Illustrated description of the invention of Miles Walker, with statement of advantages claimed. 3000 w. Elec Engr, Lond —April 8, 1910. No. 13151 A.

Repulsion Motors.

The Theory and Design of Repulsion Motors (Theorie und Berechnung des Repulsionsmotors). F. Rusch. Mathematical. Ills. Serial. 1st part. 2000 w. Elektrotech u Maschinenbau—March 6, 1910. No. 13517 D.

ELECTRO-CHEMISTRY.

Bleaching.

Electrolytic Bleaching. Ernest Reuss. Describes the use of electricity to produce bleaching liquor from salt water. Ills. 1500 w. Elec Rev, Lond—April 15, 1910. No. 13457 A.

We supply copies of these articles. See page 479.

Corrosion.

Corrosion of Iron and Steel. Editorial discussion of theories advanced. 1500 w. Ry Age Gaz—April 22, 1910. No. 13406.

Concerning the Corrosion of Metals by Water. George W. Fuller. Urges a study of this subject, giving facts from experience to make clear the difficulties of the problem. 3500 w. Eng Rec—April 23, 1910. No. 13423.

Lecture on "The Corrosion of Iron and Steel." Cecil H. Desch. Briefly considers the three forms of accelerated tests employed, and discusses the question of protection. Discussion. 7500 w. Jour W of Scotland Ir & St Inst—Nov. 19, 1909. No. 13530 N.

Dyeing.

Electrical Theory of Dyeing. W. W. Haldane Gee and William Harrison. Abstract of paper read before the Faraday Soc. Brief report of experiments. 1500 w. Elec Engr, Lond—April 15, 1910. No. 13454 A.

Electric Furnaces.

Chilling or Heating Action of Furnace Electrodes Versus Least Electrode Loss. Carl Hering. Discusses the choice from the standpoint of the designer and constructor of furnaces, and analyzes the underlying principles. 3000 w. Met & Chem Engng—April, 1910. No. 12800 C.

Electroplating.

The Importance of Cleaning the Anodes in Brass Plating. Suggestions for brass plating. 1000 w. Brass Wld—April, 1910. No. 13429.

Nitrogen.

The Fixation of Atmospheric Nitrogen and the Food Supply. Leo Frank Guttman. Reviews the work in this field and its importance. 2500 w. Can Min Jour—April 15, 1910. No. 13187.

Ozone.

See Purification, under CIVIL ENGINEERING, WATER SUPPLY.

ELECTRO-PHYSICS.

Electric Waves.

Electric Waves and the Electromagnetic Theory of Light. Abstract of Sir J. J. Thomson's concluding lecture before the Royal Institution. 2500 w. Engng—March 25, 1910. No. 12936 A.

Electromagnets.

Enameled-Wire Windings. Charles R. Underhill. Gives data in regard to the space-factor of electromagnetic windings, and the heat-resisting qualities of the insulation. 1000 w. Elec Wld—April 21, 1910. No. 13252.

Torque Tests on Electromagnets (Zugkraftversuche an Elektromagneten). Alois Berninger and Robert Edler. Reports results additional to those already published. Ills. Serial. 1st part. 1500 w. Elektrotech u Machinenbau—March 27, 1910. No. 13520 D.

Induction Coils.

The Induction Coil. Benjamin F. Bailey. Explains its principles, giving oscillograph diagrams to illustrate its operation. 4000 w. Elec Wld—April 14, 1910. Serial. 1st part. No. 13097.

Magnetic Properties.

Effect of Temperature Upon the Magnetic Properties of Electrolytic Iron. E. M. Terry. Abstract of an article in the *Phys. Rev.* Describes investigations and states results. 3500 w. Elect'n, Lond—April 15, 1910. No. 13459 A.

The Magnetic Properties of Electrolytic Iron and Some Commercial Steels. Charles F. Burgess and James Aston. Gives data of tests made on samples of electrolytic iron, together with those upon the original anode material, indicating thus the effect of refining upon the magnetic quality. 1500 w. Met & Chem Engng—April, 1910. No. 12801 C.

Resistances.

A Standard Resistance with Balanced Inductance and Capacity. S. Leroy Brown. Abstract of an article in the *Phys. Rev.* Shows that a parallel wire standard of resistance can be constructed which is free from inductance when used with interrupted steady current or with alternating current of moderate frequency. 2500 w. Elect'n, Lond—April 1, 1910. No. 13045 A.

Spark Potentials.

Alternating-Current Spark Potentials and Their Relation to the Radius of the Curvature of the Electrodes. J. de Kowalski and J. Rappel. Abstract from the *Philo. Mag.* A report of determinations by the writers, and a comparison with those of other physicists. 1200 w. Elect'n. Lond—March 25, 1910. No. 12925 A.

GENERATING STATIONS.

Auxiliary Plants.

Emergency Generating Stations for Service in Connection with Hydroelectric Transmission Plants Under Pacific Coast Conditions. A. M. Hunt. Discusses the types of stations for this service, comparing a station having generators driven by gas engines, and one in which steam-driven turbo-generators are used. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13233 F.

Reserve Power Station. M. G. Kennedy. Illustrated description of the power plant and system of the Syracuse Lighting Company. 2500 w. Elec Wld—April 21, 1910. No. 13251.

Central Stations.

Some Methods of Improving Central-Station Engine Economy. William Westerfield. Suggestions for correcting wastefulness in engine operation. 2000 w. Elec Wld—April 7, 1910. No. 12996.

New Turbine Station at Cincinnati. Illustrated detailed description of the new

Pendleton generating station, which presents many noteworthy features. 3500 w. Elec Ry Jour—April 30, 1910. No. 13578.

Combined Industrial Power and Town Lighting Plant. A plant at Manchester, Ind., a town of about 3500 population, is illustrated and described. 1200 w. Elec Wld—April 7, 1910. No. 12993.

Norfolk's Traction Power Plant. Warren O. Rogers. Illustrated description of equipment in a 10000-K.W. Curtis turbine plant. The coal handling facilities by water or rail are of special interest. 2000 w. Power—April 19, 1910. No. 13179.

Dundee and Its Electricity Station. Plans and description of a municipal plant in Scotland, costing over £100,000. 5000 w. Elec Engr, Lond—April 8, 1910. No. 13150 A.

The Dundee Municipal Power Plant. Illustrated description of an installation in Scotland that has cost over £100,000. 2000 w. Elec Rev, Lond—April 1, 1910. Serial. 1st part. No. 13040 A.

The San Paolo Power Plant. C. L. Durand. Illustrated description of a turbine-driven central station for Rome, Italy. 2500 w. Elec Rev, N Y—April 16, 1910. No. 13131.

The Shamrock Steam-Turbine Power Plant of the Hibernia Mines, Herne i. W., Germany (Das Dampfturbinenkraftwerk der Zeche Shamrock I/II der Bergwerksgesellschaft "Hibernia" in Herne i. W.) Illustrated description of an important plant serving a group of mines in this district. Ills. Serial. 1st part. 1000 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13386 D.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS; and Turbines, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Costs.

First Cost of Plant and Cost of Generating and Distributing Electricity for Lighting, Edison Electric Illuminating Co. of Brooklyn. Details of the unit cost of producing and distributing electricity for lighting. 7000 w. Engng-Con—April 6, 1910. No. 12956.

Economics.

Economies of a Small Central Station. An account of the development of the business of the Gardner, Mass., Electric Light Company. 2500 w. Elec Wld—April 7, 1910. No. 12995.

Hydro-Electric.

Analysis of Water-Power Propositions. Edwin J. Bengler. Gives an analysis with a view to assisting in the compilation of complete engineering reports on proposed water-power developments. Also discussion. 4000 w. Jour Assn of Engng Soc's—March, 1910. No. 13527 C.

Water Power and Its Development. Charles Edward Lucke. Seventh Hewitt lecture delivered at Cooper Union. Discusses considerations to be taken into account in the selection and development of suitable sites. 2000 w. Power—April 5, 1910. No. 12911.

The Utilization of Water Powers (Die Ausnützung der Wasserkräfte). Albert Loacker. A discussion of the general principles of economical water-power development. 8500 w. Die Turbine—March 20, 1910. No. 13383 D.

A General Review of Hydroelectric-Engineering Practice. Frank Koester. This second article of a series deals with head races, pressure pipes and penstocks. Ills. 3500 w. Engineering Magazine—May, 1910. No. 13589 B.

Parallel Operation of Hydroelectric Plants. W. S. Lee. Presents some advantages to be gained by operating in parallel so as to exchange power from one plant to another. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13232 F.

Hydroelectric Energy for Farmers. Illustrated description of a low-head plant in Indiana for the supply of electricity in a rural community. 2000 w. Elec Wld—April 7, 1910. No. 12994.

A Small Water Power Plant for a Paper Mill. Plan, cross-sections and description of a plant at Lincoln, N. H. 1500 w. Eng Rec—April 16, 1910. No. 13134.

Utilizing Chattahooche River Water-Power. William H. Stone. Illustrates and describes developments in progress and proposed. 3000 w. Mfrs' Rec—April 7, 1910. No. 12965.

A Hydroelectric Development on the Weber River, Utah. Illustrated description of a development of the Utah Light & Railway Co. 4500 w. Eng Rec—April 2, 1910. No. 12849.

Development of the Ninety-nine Islands Station of the Southern Power Company. Curtis A. Mees. Illustrated detailed description of the construction work on the Broad River, near Blacksburg, S. C. 4000 w. Eng Rec—April 2, 1910. No. 12827.

Dalmatian Hydroelectric Plants. Dr. Alfred Gradenwitz. Illustrated descriptions of the Jarnge and Manojlovae stations in Austria-Hungary, on the river Kerka. 2000 w. Power—April 26, 1910. No. 13475.

The Steyrdurchbruch Electrical Plant (Das Elektrizitätswerk Steyrdurchbruch). Describes an interesting small plant in Austria. Ills. 2200 w. Elektrotech u Maschinenbau—March 13, 1910. No. 13516 D.

The Valtellina Hydro-Electric Plants and the Milan Municipal Installations (Gli Impianti idroelettrici di Valtellina e le Installazioni elettriche del Comune di Milano). A. Manfredini. An exhaustive

description, discussing both the technical and economic features. Ills. Serial. 1st part. 5000 w. Monit Tech—March 10, 1910. No. 13349 D.

Isolated Plants.

Electric Lighting and Power Plant of the Coast Artillery School, Fort Monroe, Va. I. N. Lewis. Illustrated description of a very complete plant for supplying heat, power and light. 3000 w. Jour U S Art—March-April, 1910. No. 13282 D.

Electricity in a Modern Infirmary. Illustrates and describes details of the electrical and mechanical installation in the new infirmary at Oak Forest, Ill. 3000 w. Elec Rev, N Y—April 2, 1910. No. 12908.

Rates.

An Equitable Sliding Scale for Rates of Electric Power. J. B. Gordon. Develops formulæ and explains method of determining rates according to a fixed law. 1800 w. Eng News—April 7, 1910. No. 13000.

Price of Electricity. R. S. Hale. Abstract of a paper before the New England section of the Nat. Elec. Lgt. Assn. Discusses the principles on which rates are based by the Boston Edison Co. 2500 w. Elec Rev, N Y—April 23, 1910. Serial. 1st part. No. 13419.

Switch Gear.

Concrete Construction of Switch Gear Compartments in European Power Plants. Stephen Q. Hayes. Illustrates and describes examples of European construction, outlining results obtained. 3500 w. Elec Jour—April, 1910. No. 13207.

Ironclad Switch-Gear for Mines. Illustrated description of the latest design of British Westinghouse Elec. & Mfr. Co., Ltd. 1200 w. Engng—April 8, 1910. No. 13165 A.

LIGHTING.

Arc Lamps.

A Short Flame Arc Lamp. A lamp known as the Timar-Dreger lamp as described by Prof. W. Wedding in the E. T. Z. No. 2, 1910. Ills. 700 w. Elec Rev, Lond—April 8, 1910. No. 13153 A.

Automobile.

See Lighting, under MECHANICAL ENGINEERING, AUTOMOBILES.

Chemistry.

Some Chemistry of Light. Dr. W. R. Whitney. Abstract of a presidential address to the American Chemical Society. Historical review of light production from the viewpoint of the chemist. 3500 w. Elec Rev, N Y—March 26, 1910. No. 13015.

Illumination.

Theoretical Notes on Interior Lighting. W. E. Barrows. Considers systems of illumination, the intensities for various classes of interior lighting, and related subjects. 1500 w. Elec Rev, N Y—April 16, 1910. Serial. 1st part. No. 13132.

Modern Stage Illumination. Dr. A. Neuburger. Illustrates and describes modern methods, especially the Fortuny system. 1200 w. Sci Am Sup—April 16, 1910. No. 13112.

A Visual Acuity Test Object. Herbert E. Ives. Illustrated description of a composite object composed of superposed gratings, and report of results obtained. Also editorial. 2500 w. Elec Wld—April 14, 1910. No. 13095.

Incandescent Lamps.

The Effect of Regulation on Incandescent Lamps. L. L. Elden, in *Nat. Elec. Lgt. Assn. Bul.* The carbon-filament lamps only are considered. 1200 w. Elec Rev, N Y—April 30, 1910. No. 13621.

Searchlights.

Searchlights: Other Means of Illumination and Telephones at Port Arthur. Information translated from the *Mitteilungen ueber Gegenstaende des Artillerie- und Geniewesens.* 2000 w. Jour U S Art—March-April, 1910. No. 13287 D.

Electrical Searchlights in Coast Defense (I Proiettori elettrici per la Difesa delle Coste). Giulio Bertolini. An exhaustive discussion of the military value of searchlights. Ills. 20000 w. Riv Marit—March, 1910. No. 13342 E + F.

Street.

Steet Illumination. Francis Jehl. A report of photometric tests of street lighting in Budapest. 2000 w. Elec Wld—April 28, 1910. No. 13561.

A Comparison of Cost and Efficiency of Methods of Street Lighting. N. R. Birge, in *Gen. Elec. Rev.* 3000 w. Munic Engng—April, 1910. No. 13224 C.

MEASUREMENT.

Electrochemical Equivalents.

Researches at the Central Electrical Laboratory on the Electrochemical Equivalent of Silver (Recherches effectuées au Laboratoire Central d'Electricité sur l'Equivalent électrochimique de l'Argent). F. Laporte and P. de la Gorce. Describes methods employed and gives results. Ills. 14000 w. Bul Soc Int des Elecns—March, 1910. No. 13314 F.

Meters.

Inexpensive Alternating Current Station Recording Watt Hour Meters. H. R. Mason. Explains how to adapt the ordinary type of service meter for use in alternating-current stations. 1800 w. Power—April 19, 1910. No. 13182.

Meter Corrections (Corrections à Appliquer aux Compteurs servant à l'Enregistrement de l'Energie électrique). A. Combemale. A mathematical discussion of the correction for the errors of the meter which vary with the load, to be applied to the Thomson d. c., two-wire meter. Ills. Serial. 1st part. 1800 w. L'Elecn—March 19, 1910. No. 13327 D.

We supply copies of these articles. See page 479.

Motor Testing.

The Determination of the Efficiency of Continuous-Current Machines. W. C. Clinton. Remarks on the methods used. Diagrams. 1000 w. Elect'n, Lond—April 15, 1910. No. 13460 A.

Rating and Testing of Motors for Intermittent Working. Dr. R. Pohl. Abstract of a paper read before the Yorkshire local section of the Inst. of Elec. Engrs. Shows that short-time tests are very misleading. Discusses the proposed tests of Goldschmidt and Broughton, and suggests a continuously running test. 3500 w. Elect'n, Lond—March 25, 1910. No. 12923 A.

Standards.

An International Co-operative Investigation on Electrical Standards. Edward B. Rosa. The latest information relating to the international standardization of concrete electrical units. Also editorial. 2500 w. Elec Wld—April 7, 1910. No. 12980.

Researches at the Central Electrical Laboratory on the Standards of Resistance and of Electromotive Force (Recherches faites au Laboratoire Central d'Electricité sur l'Etalon de Résistance et l'Etalon de Force électromotrice). R. Jouaust. Describes methods and gives results. 10000 w. Bul Soc Int des Elecns —March, 1910. No. 13315 F.

Transformer Testing.

Testing Transformers. J. W. Himmelsbach. Explains how to determine losses in transformer windings and how to keep card records of tests. 800 w. Power—April 12, 1910. No. 13028.

Units.

See Standards, under MEASUREMENT.

TRANSMISSION.

Cables.

Cost of Cable Laying. E. Capone. Information relating to the cost of recent cable laying in England, giving tables for computing costs and explaining their use. 1800 w. Tram & Ry Wld—April 7, 1910. No. 13443 B.

Conduits.

Underground Conduits. Paul B. Witham. Presents the advantage of a general plan and system in the location of conduits, pipes, etc., in city streets. Ills. 700 w. Elec Wld—April 28, 1910. No. 13564.

The Laying of Vitirified Conduit. Harry C. Spillman. Discusses considerations governing choice of route, type of conduit, and method of installation. Ills. 1500 w. Elec Wld—April 7, 1910. No. 12997.

Direct Current.

The Series System of High-Tension, Direct-Current Transmission (Transporte de Energia Electrica por Corriente continua a alto Voltaje, Sistema "Serie"). Jaime Font Mas. The first part discusses the Moutier-Lyon installation. Ills. Serial. 1st part. 3000 w. Energia Elec—March 25, 1910. No. 13353 D.

Lightning Protection.

Lightning Protection. Percy H. Thomas. Considers the effects of lightning, and the protective devices for line and station. Ills. 2000 w. Pro Am Inst of Elec Engrs —April, 1910. No. 13236 F.

Line Design.

Transmission Line Calculations. John F. H. Douglas. Gives a short method for determining the regulation. 800 w. Elec Wld—April 28, 1910. No. 13563.

The Study of an Electricity Distribution Project (Noté sur l'Etude d'un Projet de Distribution d'Energie électrique). F. Scoumanne. A detailed demonstration of various methods of calculating distribution networks. Ills. 9000 w. Soc Belge d'Elecns—March, 1910. No. 13303 E.

Lines.

The Developed High Tension Net-Work of a General Power System. Paul M. Downing. Confined to conditions in California at the present time. Ills. 4500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13234 F.

Poles.

Steel Structures for High-Tension Transmission Lines and Special Crossings. W. K. Archbold. Illustrates and describes types of structures discussing their design and construction. 1500 w. Elec Jour—April, 1910. No. 13206.

Regulations.

The German and Vienese Safety Regulations for Overhead Wires (Ueber die Deutschen und Wiener Sicherheitsvorschriften für Freileitungen). A. Kohler. A comparison of the rules of the German Association of Electrical Engineers and the Vienna Electrical Society. Ills. 4000 w. Elektrotech u Maschinenbau—March 27, 1910. No. 13519 D.

Substations.

An Arc Lighting Substation. M. Stoppoloni. Illustrated description of a motor-generator substation in Milan, Italy. 2000 w. Elec Wld—April 28, 1910. No. 13559.

Transformers.

The Drying of High-Tension Transformers and Transformer Oil. R. W. Krass. Discusses methods of effecting the separation of oil and water when moisture is present in small quantities. Ills. 1500 w. Sib Jour of Engng—April, 1910. No. 13540 C.

Ratings of Single-Phase Transformers for Grouping on Polyphase Circuits. H. C. Soule. Analyzes the various groupings, explaining why certain groupings should have transformers of larger rated kilovolt-ampere capacity than indicated. 1200 w. Elec Jour—April, 1910. No. 13209.

We supply copies of these articles. See page 479.

Operation of Delta and V-Connected Transformers in Parallel. E. C. Stone. Considers transformer capacities available with various combinations of V and delta groups of units. 1000 w. Elec Jour—April, 1910. No. 13210.

Reactance of Shell-Type Transformers. G. Faccioli. Explains a method for determining the local magnetic leakage reactance. 2000 w. Elec Wld—April 14, 1910. No. 13096.

MISCELLANY.

Aluminium.

Resistivity and Thermo-Electric Properties of Aluminium and Copper-Aluminium Alloys (Resistivité et Thermo-Electricité des Aluminiums et des Cupro-Aluminiums). H. Pécheux. Reports results of researches on the influence of impurities and of copper on the electrical properties of aluminium. Ills. 3000 w. Rev Gen des Sci—March 30, 1910. No. 13320 D.

Insulating Materials.

Impregnation of Coils with Solid Compounds. J. R. Sanborn. Illustrates and describes the process and apparatus used in impregnating coils, the materials for the compound, methods of testing, etc. 3500 w. Elec Jour—March, 1910. No. 12313.

Insulating Oils (Note sur les Huiles d'Isolement). A brief review of an exhaustive report on the subject recently presented to the Sociéte Belge d'Electriciens. Ills. 3000 w. Soc Belge d'Elecns—Feb., 1910. No. 12620 E.

The Physical Properties of Switch and Transformer Oils. W. Pollard Digby and D. B. Mellis. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes investigations of some of the physical and chemical changes in oils, due to their use in transformers and switches. 5000 w. Elect'n, Lond—April 1, 1910. No. 13041 A.

INDUSTRIAL ECONOMY.

Apprenticeship.

A Successful Apprenticeship System in a Large Plant. Charles H. Logue. Brief account of training methods at the East Pittsburg Works of the Westinghouse Co. Ills. 1800 w. Am Mach—Vol. 33. No. 16. No. 13247.

Apprenticeship System of the Fore River Shipbuilding Co. J. E. Neary. An explanation of a system that has given satisfactory results. Ills. 1200 w. Am Mach—Vol. 33. No. 17. No. 13553.

Industrial Apprenticeship and Obligatory Professional Instruction (L'Apprentissage industriel et l'Enseignement professionnel obligatoire). P. Astier. A discussion of conditions in France and means of improving them. 4500 w. Tech Mod—March, 1910. No. 13323 D.

See also Education, under INDUSTRIAL ECONOMY.

British Trade.

Foreign Competition: Its Growth and Effects. W. O. Horsnaill. A discussion of the British engineering industry and its future outlook. 3000 w. Elec Rev, Lond—April 8, 1910. No. 13154 A.

Canada.

Engineering in Canada. Walter J. Francis. Reviews what has been accomplished and considers the future of engineering in Canada. 3000 w. Ap Sci—March, 1910. No. 13214 C.

Depreciation.

Depreciation. Major W. A. J. O'Meara. Abstract of paper read before the Inst. of P. O. Elec. Engrs. Discusses physical decay, obsolescence, inadequacy, tenure of holding, etc., and the life of machinery and other plant. 4500 w. Elect'n, Lond—April 8, 1910. No. 13157 A.

The Depreciation and Maintenance of Electrical Equipment. George W. Cravens. Considering the different methods of accounting in use, advocating the sliding scale method. 3500 w. Elec Rev, N Y—April 23, 1910. No. 13420.

Education.

Industrial Education. K. A. Mackenzie. Discussion of the needs in this line in Canada. 2500 w. Ap Sci—March, 1910. No. 13219 C.

The Movement Toward a National System of Technical Education. Dr. R. Pohl. Abstract of a paper read before the Assn. of Teachers in Tech. Inst. 2200 w. Elect'n, Lond—April 15, 1910. No. 13461 A.

Criticism of the Engineering Schools. Dugald C. Jackson. A lecture before Steyens Engng. Soc. 4000 w. Stevens Ind—March, 1910. No. 13499 D.

Education for Leadership in Electrical Engineering. Samuel Sheldon. Aims to give the characteristics of such leaders, considering what education can do toward developing the essentials, and discussing problems related. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13228 F.

The Apprenticeship Course and the Engineering Graduate. Charles F. Scott. Explains how experience and opportunity may be secured in the apprenticeship course of an electric manufacturing

company. 3000 w. Elec Jour—April, 1910. No. 13208.

The Mining Department of the University of Leeds. Illustrates and describes the work in mining and metallurgy. 1500 w. Col Guard—March 24, 1910. Serial. 1st part. No. 12933 A.

The Reform of Technical Education in France and the Reorganization of Apprenticeship (La Réforme de l'Enseignement technique en France et la Reorganisation de l'Apprentissage). G. Zeigler. A general discussion of problems pressing for solution. 3300 w. Rev d'Econ Indus—March 20, 1910. No. 13300 D.

Employers' Liability.

Employers' Liability Insurance. Miles M. Dawson. From an address before the Nat. Metal Trades Assn. Discusses how employers' associations of the United States may improve on present methods. 2500 w. Ir Age—April 21, 1910. No. 13278.

Engineering.

Presidential Address of James Charles Inglis. Discusses the professional standing of the civil engineer and the position he occupies in relation to certain economic questions. 5800 w. Inst of Civ Engrs—Nov. 2, 1909. No. 13277 N.

Engineering Ethics.

Principles of Professional Practice. A circular letter issued by the American Institute of Architects offering advice concerning the principles that should govern conduct. 1700 w. Eng Rec—April 16, 1910. No. 13139.

Exhibitions.

The Brussels International Exhibitions. Information concerning the exhibition to be opened April 23, 1910. Plans. 2000 w. Engng—April 1, 1910. No. 13055 A.

Labor Insurance.

Unemployment Insurance. Discusses in detail the Bill for the Insurance of Workmen Against Unemployment, which it is expected will soon be introduced in England. 2000 w. Engr, Lond—April 8, 1910. Serial. 1st part. No. 13172 A.

See also Employers' Liability, under INDUSTRIAL ECONOMY.

Management.

Modern Methods of Shop Management. Frederick A. Waldron. Gives details of a system taken from actual practice. 5000 w. Ir Age—April 28, 1910. No. 13566.

Saving Waste in Manufacturing—A Field of Work in Which the Technical Graduate Might Well Look for a Future. J. C. Armer. 1800 w. Ap Sci—March, 1910. No. 13216 C.

Time Keeping and Labour Distribution in the Foundry. Victor R. Claydon. An explanation of simple and reliable methods of foundry management and accounting. 3300 w. Engineering Magazine—May, 1910. No. 13592 B.

See also same title, under RAILWAY ENGINEERING, MISCELLANY.

Patents.

How to Keep an English Patent Alive. Gives the most convenient methods by which a person foreign to England may comply with the law. 1200 w. Eng News—April 21, 1910. No. 13256.

Patent Legislation (Octrooiwetgeving). G. H. E. Bergsma. A discussion of the patent situation in the Netherlands. Ills. 21000 w. De Ingenieur—March 26, 1910. No. 13525 D.

Strikes.

Phases of the Philadelphia Strike. Daniel T. Pierce. Information as to phases of the strike on the system of the Philadelphia Rapid Transit Co. 2200 w. Elec Ry Jour—April 23, 1910. No. 13298.

Trusts.

The Operation of Kartels (Fonctionnement de quelques Kartels). Notes from a recent book by M. Huré on the development and operation of the German kartel system. Serial. 1st part. 2500 w. Rev d'Econ Indus—March 20, 1910. No. 13302 D.

Wage Systems.

Compensation of Workmen and Efficiency of Operation. H. L. Gantt. This fourth article of a series gives colored charts showing graphically the results, and comments making clear the benefits of the bonus system in fixing habits of industry. 6000 w. Engineering Magazine—May, 1910. No. 13588 B.

MARINE AND NAVAL ENGINEERING.

Barges.

The "Viking"—Self-Dumping Deck Scow. Illustrated description of a novel system devised by A. F. Viking. 1200 w. Sci Am—April 16, 1910. No. 13109.

Battleships.

H. M. S. Colossus. Illustrated description of a recently launched battleship. 700 w. Engr, Lond—April 15, 1910. No. 13467 A.

The Japanese Battleship Satsuma. Illustration, with brief description. 1000 w. Engr, Lond—April 15, 1910. No. 13470 A.

The Projected French 23,400-Ton Battleships. Illustration and information concerning the projected French battleships and their armament. 1000 w. Engr, Lond—April 8, 1910. No. 13174 A.

The Disposition of Guns on Battleships (Sulla Disposizione delle Artig-

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lierie a Bordo delle grandi Navi da Battaglia). A discussion of the disposition of armament on the latest British battleships. Ills. 2500 w. Riv Marit—March, 1910. No. 13343 E + F.

British Navy.

Twenty-one Years of British Warship Building. Archibald S. Hurd. The development of the British fleet, and the activity in warship building and allied industries. 3500 w. Cassier's Mag—April, 1910. No. 13188 B.

Electric Power.

The Electric Motor for Marine Propulsion. William P. Durtnall. Read before the Inst. of Nav. Archts. Considers the possibilities of electrical power generation and transmission and means of regulating propeller speed in steam vessels. 8000 w. Elec Engr, Lond—March 25, 1910. Serial. 1st part. No. 12922 A.

Marine Propulsion by Electric Motors. Henry Alexander Mavor. Discusses the problem of economical power production, describing a change-speed gear for large steamers. Discussion. Ills. 21500 w. Inst of Civ Engrs, No. 3822—Dec. 7, 1909. No. 13272 N.

Improved Apparatus for Warping, Winding, Hoisting, Etc., on Board Ships. Jas. A. Liddle. Read before the Inst. of Marine Engrs. States the requirements of electrical machinery on board ship, and discusses details. 2500 w. Mech Wld—April 1, 1910. Serial. 1st part. No. 13054 A.

Ferry Steamers.

Some Notes on the Erection of the Baikal Railway Ferry Steamers. Isaac O. Hondy. Illustrated description of the ice breaking train ferry steamers and their construction. 2500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1910. No. 13413 N.

Grain Elevators.

The Mitchell Cantilever Grain Elevator. August F. Bock. Illustrated description of an interesting English floating elevator. 1200 w. Ir Age—April 7, 1910. No. 12947.

Gunboats.

Gunboat for Macao. Illustrated description of a shallow-draught gunboat built for the Portuguese Government. 1000 w. Engng—April 15, 1910. No. 13462 A.

Internal-Combustion Engines.

Internal-Combustion Marine Engines. Linton Hope. Deals with the application of the internal-combustion engine to fishing and commercial vessels. Ills. 5000 w. Engng—April 1, 1910. No. 13058 A.

Action and Design of Four Cycle Marine Gas Engines. Albert H. Ziegler. Illustrates and describes various forms of combustion chambers, valves, piston heads, etc. 3500 w. Am Mach—Vol. 33. No. 15. No. 13084.

Lifeboats.

Motor Lifeboats. J. R. Barnett. Read before the Inst. of Naval Archts. Illustrates and describes the motor lifeboats of the Royal National Lifeboat Institution. 3000 w. Engng—April 1, 1910. No. 13057 A.

Motor Boats.

The International Motor Boat and Motor Exhibition (Internationale Motorboot- und Motorenausstellung). Illustrated description of the exhibits at the Berlin show. 6000 w. Motorwagen—March 31, 1910. No. 13393 D.

The Motor Boat and Motor Exhibition at Berlin, 1910 (Internationale Motorboot- und Motoren-Ausstellung Berlin, 1910). Describes the exhibits and discusses the tendencies they indicate. Serial. 1st part. 2000 w. Zeitschr d Mit Motorwagen Ver—March 31, 1910. No. 13390 D.

Motor Boats (Motorbootwesen). Ernst Andreas. A general and comprehensive discussion of their design and construction. Ills. Serial. 1st part. 3000 w. Zeitschr d Mit Motorwagen Ver—March 15, 1910. No. 13388 D.

The Design of High-Speed Motor Boats (Gesichtspunkte für die Konstruktion schnellaufender Motorboote). W. Kiwull. Mathematical discussion of the design of the hull and power plant. Ills. Serial. 1st part. 5000 w. Zeitschr d Mit Motorwagen Ver—March 15, 1910. No. 13389 D.

Modern High-Speed Motor Boats (Einiges über moderne Motorenboote). Conrad Harmsen. Mathematical discussion of their design. Ills. Serial. 1st part. 3500 w. Motorwagen—March 20, 1910. No. 13392 D.

Modern Motor Boats. George H. Cutbush. Reviews present practice showing how internal-combustion engines are altering conditions and giving efficient service. 2500 w. Int Marine Engng—April, 1910. No. 12818 C.

A Small Off-Shore Cruiser. Stephen P. M. Tasker. Illustrated description of a motorboat of 31-foot length. 1200 w. Int Marine Engng—April, 1910. No. 12815 C.

See also Internal Combustion Engines, and Lifeboats, under MARINE AND NAVAL ENGINEERING.

Naval Efficiency.

The Essentials of Naval Efficiency in an Engineering Age. A lecture by Rear Admiral George W. Melville, before the Stevens Engng. Soc. Considers the changes in the material side of the question and the essentials for its efficiency, and also the requirements in the personnel. 4500 w. Stevens Ind—Jan., 1910. No. 13497 D.

Oil Fuel.

See Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

We supply copies of these articles. See page 479.

Porhydrometer.

The Weight of Cargoes. A. Murray. Read before the Inst. of Nav. Archts. Describes a new method of ascertaining the weight of cargoes on board ship, by the use of the "Porhydrometer," invented by Emilio de Lorenzi, of Genoa. Ills. 1200 w. Engng—April 8, 1910. No. 13167 A.

Propellers.

Some Considerations Regarding the Phenomena of Propulsion. J. B. Henderson. Read before the Inst. of Nav. Archts. An analysis of the phenomena of propulsion, examining the jet propeller, and screw-propulsion. 5000 w. Engng—March 25, 1910. No. 12939 A.

Model Screw-Propeller Results: A Comparison. T. B. Abell. Read before the Inst. of Nav. Archts. Compares results of experiments made by D. W. Taylor, with results obtained by R. E. Froude to see how far they agree. Also notices some features brought out by their analysis. Diagrams. 3500 w. Engng—April 15, 1910. No. 13466 A.

Experimental Investigations on Wake and Thrust Deduction Valves. W. J. Luke. Read before the Inst. of Nav. Archts. Gives results of recent experiments on wake and thrust deduction, made with twin and single screws. Also editorial. 6000 w. Engng—March 25, 1910. No. 12938 A.

The Erosion of Bronze Propellers. Illustrated account of serious erosion believed to be one effect of the high speed turbine. 700 w. Sci Am—April 23, 1910. No. 13267.

Shaft Horse Power.

The Measurement of Shaft Horse-Power. B. Hopkinson. Read before Inst. of Naval Archts. Notes on the measurement of shaft horse-power, discussing the relation between twist and torque. 2500 w. Engng—April 1, 1910. No. 13059 A.

Ship Resistance.

Ship-Resistance: A Numerical Analysis of the Distribution of Effective Horse-Power. T. H. Havelock. Read before the Ap. Sci. Sec. of the Phil. Soc. of the Univ. of Durham. An outline is given of the general theory of ship-resistance, and a study of the distribution at different speeds. 2200 w. Engng—April 8, 1910. No. 13168 A.

Researches on the Resistance of Boats to Traction (Recherches sur la Resistance à la Traction des Bateaux). M. Clerc. A discussion of the measurement of speed by a recording hydrokinemometer based on the principle of the Pitot tube. Ills. 3500 w. Ann d Ponts et Chaussées—1910-I. No. 13308 E + F.

Ship Speed.

Speed and Its Attainments in Different Types of Ships. Herbert C. Sadler. Discusses speed in relation to size, and speed in relation to type or form of vessel. 3000 w. Stevens Ind—Jan., 1910. No. 13498 D.

Steamboats.

The New River Steamers City of Philadelphia and City of Wilmington. Illustrated description of new vessels for service between Philadelphia, Pa., and Wilmington, Del. 2000 w. Int Marine Engng—April, 1910. No. 12813 C.

Steam Boilers.

Notes on Marine Boiler Design, Construction and Economy. D. Myles. Calls attention to recent modifications and improvements. General discussion. 2 plates. 10000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1910. No. 13412 N.

Resumed Discussion on Mr. D. Myles's Paper on "Notes on Marine Boiler Design, Construction and Economy." 6500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—April, 1910. No. 13536 N.

The Boiler and Engine Equipment of the German Naval Vessel "Drache" (Die Kessel- und Maschinenanlage des deutschen Artillerietenders "Drache"). Herr Landahn. Illustrated detailed description of a vessel for high-speed service, equipped with the Schmidt superheater. Serial. 1st part. 4500 w. Schiffbau—March 9, 1910. No. 13379 D.

Steam Engines.

See Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Steamships.

The South African Mail Steamer "Balmoral Castle." Illustrated detailed description of this fine merchant vessel. Plates. 2500 w. Engng—April 8, 1910. Serial. 1st part. No. 13166 A.

Steam Turbines.

A New Method of Reversing Turbines. Illustrates and describes Foettinger's turbine propulsion system with turbo-transformers. 3300 w. Sci Am Sup—April 2, 1910. No. 12787.

Mechanical Gearing for Marine Turbines. C. A. Parsons. Read before the Inst. of Nav. Archts. Considers the application of the marine steam-turbine and mechanical gearing to merchant ships. Ills. 2000 w. Engng—March 25, 1910. No. 12934 A.

The Föttinger Hydraulic Gear. Dr. Alfred Gradenwitz. Illustrated description of this hydraulic reduction and reversing gear for turbines, giving theory of the action and the results obtained at the Vulcan shipyards in Germany. 3500 w. Power—April 12, 1910. No. 13026.

Mr. Y. Wadajaki's Reply to the Discussion on his Paper on "The Adaptation of Steam Turbines for Propulsion of Vessels at Moderate Speeds." 2200 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1910. No. 13411 N.

We supply copies of these articles. See page 479.

Steam Turbines in the French Navy (Die Anwendung von Dampfturbinen für den Antrieb von Kriegsschiffen der französischen Marine). E. Clergeau. Describes the turbine-propelled vessels and their equipment. Ills. Serial. 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13385 D.

Submarines.

The Stability of Submarines. Bernard C. Laws. An illustrated discussion of problems of equilibrium when submerged. 3000 w. Cassier's Mag—April, 1910. No. 13190 B.

Characteristics of Submarines (Rohentwurf eines Unterseebootes). K. Dietze. Gives average dimensions and characteristics of submarines deduced from existing types. 2800 w. Schiffbau—March 9, 1910. No. 13380 D.

Survey Vessels.

The Most Curious Craft Afloat. L. A. Bauer. An illustrated account of the work of the non-magnetic yacht "Carnegie," explaining the use of the compass in navigation, and giving principal facts regarding the vessel and its equipment. 5500 w. Nat Geog Mag—March, 1910. No. 13071 C.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Abbott-Detroit.

Pertinent Features of Abbott-Detroit Car. Illustrated description of the general characteristics. 2000 w. Automobile—April 28, 1910. No. 13582.

Cadillac.

The 20-30 h.p. Cadillac. Illustrated detailed description. 1200 w. Autocar—April 2, 1910. No. 13038 A.

Carbureters.

The Carbureter. Its Adjustment, and the Novice. Herbert L. Towle. Illustrates and describes various types and their working. 1500 w. Automobile—March 31, 1910. Serial. 1st part. No. 12805.

Cino.

Cino. Brief illustrated description of a touring car built in Cincinnati, Ohio. 500 w. Automobile—April 7, 1910. No. 13013.

Commercial Vehicles.

Lansden Storage Battery Trucks. Illustrated description of trucks using the Edison storage battery. 800 w. Ir Age—April 7, 1910. No. 12944.

De Dion.

The 14 h.p. De Dion-Bouton. Brief illustrated description of this model and the automatic carbureter adopted. 2000 w. Autocar—March 26, 1910. No. 12920 A.

Dennis.

The 20 h.p. Four Cylinder Four-Speed Dennis Car. Illustrates and describes the Dennis chassis, embodying the Dennis worm-drive. 700 w. Autocar—April 9, 1910. No. 13149 A.

Garages.

Commercial Vehicle Garage Management. Harold H. Brown. Gives details of the system adopted by the Autocar Co. in the conduct of its motor wagon garage in New York. 2500 w. Com Veh—April, 1910. No. 12948 C.

Ignition.

Ignition Troubles, Their Causes and Prevention (Zundaussetzer, ihre Ursachen und Beseitigung). Konradin Stauffer. A practical discussion. Ills. 4500 w. Zeitschr d Mit Motorwagen Ver—March 31, 1910. No. 13391 D.

Industry.

Our Marvelous Automobile Industry. Information and illustrations showing the rapid development, and business methods. 2000 w. Sci Am—April 9, 1910. No. 12982.

Lighting.

Electric Lighting for Motor Cars. An illustrated series of articles describing systems and mechanisms employed. 1700 w. Prac Engr—March 25, 1910. Serial. 1st part. No. 13158 A.

Electric Light for Cars. An illustrated discussion of the special requirements of an automobile dynamo. 3000 w. Auto Jour—April 16, 1910. No. 13440 A.

Maintenance.

Instructions for Caretakers. Albert L. Clough. Detailed instructions for regular care. 1500 w. Horseless Age—April 20, 1910. No. 13587.

Materials.

Automobile Materials. John Coapman. Gives data collected relating to the analyses and heat treatment of material used. 2500 w. Horseless Age—March 30, 1910. No. 12904.

Mandalay.

The Mandalay "Seventeen." Illustrated description of a small car of the M M class of British build. 1600 w. Auto Jour—March 26, 1910. No. 12921 A.

Metallurgique

The 12-14 H. P. Metallurgique Transmission. Illustrated description. 1000 w. Auto Jour—April 9, 1910. No. 13147 A.

Midland.

Midland Model L Forty Horse Power Car. Illustrates and describes a 1910 model. 1500 w. Horseless Age—April 13, 1910. No. 13122.

Motor Cooling.

In the Solution of Some Radiator Problems. Reviews developments in automobile radiators, and discusses difficulties.

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Ills. 1500 w. Automobile—April 21, 1910. No. 13294.

An Investigation of Motor-Cooling Devices (Untersuchung von Automobilkühlern). Walther v. Doblhoff. Describes methods of testing the efficiency of radiators and gives results. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—March 19, 1910. No. 13513 D.

Motor Lubrication.

Lubrication for Internal Combustion Engines. G. H. Baillie. Read before the Royal Automobile Club. Discusses the systems of lubrication, and advantages and disadvantages of forced lubrication. 3000 w. Autocar—March 26, 1910. No. 12919 A.

Motor Power.

Loss of Power in the Motor Car Engine. Donald Hampson. Explains the chief troubles causing power loss. 1800 w. Horseless Age—April 6, 1910. No. 13016.

Motor Rating.

On the Rating of Petrol Engines for Competition Purposes. G. A. Burls. Gives the arguments favoring the stroke-bore ratio theory, and refers to other considerations of interest. 1800 w. Auto Jour—April 9, 1910. No. 13148 A.

Motors.

The Phantom of Flexibility. Considers the limitations of the petrol motor and the possibilities of further improvements in variable speed gears. Also editorial. 2500 w. Autocar—April 2, 1910. No. 13037 A.

Gas Displacement in Two Cycle Cylinders. F. E. Watts. Describes apparatus used and experiments made by the writer. 1200 w. Horseless Age—March 30, 1910. No. 12903.

Motor Starting.

Starting Crank Design. F. E. Watts. Considers some of the causes which affect the starting of a motor and develops a formula for the proper length of starting crank. 1600 w. Horseless Age—April 27, 1910. No. 13586.

Motor Testing.

The Progressive Testing of Motors and Cars. Illustrates and describes the scheme employed by the Regal Motor Car Co., Detroit, Mich. 1200 w. Automobile—April 28, 1910. No. 13581.

The Testing of Automobile Engines on a Commercial Basis. Illustrates and describes factory tests which demonstrate the actual performance. 1300 w. Ir Trd Rev—April 7, 1910. No. 12971.

Test of 20-H.P. Franklin Air-Cooled Motor. R. P. Lay and L. R. Evans. Tests made to determine the variation in volumetric efficiency caused by changing the timing, the shape and size of the valves and the material used for the cooling fins. Ills. Curves. 2500 w. Sib Jour of Engng—April, 1910. No. 13541 C.

Test of Franklin Air-Cooled Motor. L. R. Evans and R. P. Lay. A study of the variation in the volumetric efficiency of the motor caused by changing the timing, the shape and size of the valves, and the material used for the cooling fins. 2500 w. Automobile—March 31, 1910. No. 12806.

Motor Valves.

Overhead Valve Arrangements. Frederick Strickland. Drawings and descriptions of various arrangements, discussing the form of combustion chambers of gasoline motors, and comparing the advantages. 3000 w. Horseless Age—March 30, 1910. No. 12905.

Omnibuses.

Motor Omnibuses for Transportation in Urban Communities (I Servizi di Trasporto in Comuni urbani con Omnibus automobili). U. Baldini. Discusses the development of motor omnibuses and their economy as a means of public transportation. Ills. Serial. 1st part. 4000 w. Ing Ferro—March 16, 1910. No. 13352 D.

Repairs.

Rattling Noises in Cars and Their Prevention. Albert L. Clough. Discusses causes and the remedy. 2000 w. Horseless Age—April 20, 1910. No. 13400.

Pointers in Repair Work—Referring Specifically to Valves. Methods and materials are discussed. Ills. 2200 w. Automobile—April 14, 1910. No. 13114.

Sleighs.

Wolseley Sleighs for the South Pole. Illustrated description of the motor sleighs constructed for Captain Scott to assist him in his projected dash for the south pole. 800 w. Auto Jour—April 2, 1910. No. 13039 A.

Automobiles with Snow Runners (Automobile à Patins pour la Circulation sur la Neige). E. Girardault. Describes various systems of propulsion, particularly the La Besse. Ills. 3500 w. Génie Civil—March 5, 1910. No. 13334 D.

Speedwell.

Speedwell. Illustrated detailed description of the Speedwell cars, especially the "Speedwell 50." 2000 w. Automobile—April 21, 1910. No. 13293.

Stearns.

Stearns. Illustrated descriptions of the Model 30-60, and the general characteristics of other Stearns models. 1800 w. Automobile—April 28, 1910. No. 13580.

Steering Gears.

Angles of Steering Knuckle Arms. Herbert C. Snow. Gives calculations for determining the proper angle, illustrating by examples. 2000 w. Horseless Age—April 13, 1910. No. 13121.

Tires.

Does It Pay to Retread Tires? Charles B. Hayward. A discussion of both theory and practice. 3000 w. Horseless Age—March 30, 1910. No. 12902.

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Transmissions.

Frictional Drive. Albert L. Clough. Explains the friction drive and the advantages claimed. 1200 w. Horseless Age—April 6, 1910. No. 13017.

COMBUSTION MOTORS.

Aeronautic Motors.

Development of Motors for Aeroplane Requirements. Augustus Post. Interesting designs and constructions are illustrated and described. 1500 w. Am Mach—Vol. 33. No. 14. No. 12953.

Suggestions in the Design of Aeronautic Motors. Harry E. Dey. Suggestions from the writer's experience, giving a general outline. 3500 w. Mach, N Y—April, 1910. No. 12901 C.

Light and Reliable Gas Engines. A. S. Atkinson. Discusses the principles of the design of gas engines for airships and aeroplanes. 1700 w. Mach, N. Y—April, 1910. No. 12897 C.

New Rotary Gas Engine for Aerial Navigation. Chester L. Lucas and John J. Ross. The L. A. W. 30 H. P. gas motor is illustrated and described. 2000 w. Mach, N Y—April, 1910. No. 12894 C.

Carburetors.

Carburetors and Vaporizers. Charles A. Schranz. Discusses their design and use. 1500 w. Mach, N Y—April, 1910. No. 12900 C.

Gas Cleaning.

See Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

Gas Engines.

General Maintenance and Special Troubles. R. H. Thomas. Read before the Nat. Com. Gas Assn. Especially emphasizes the need of cleanliness and lubrication. 2500 w. Gas Engine—April, 1910. No. 12961.

Gas Engines in City Railway and Lighting Service. E. D. Latta, Jr. Describes the apparatus and equipment of the Charlotte (N. C.) Electric Railway Co., using gas engines for prime movers, giving report of reliability, efficiency and adaptability, with data of producer gas manufacture, and remarks on the adaptability of gas engines to certain kinds of work. Ills. 8800 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13231 F.

See also Internal-Combustion Engines, under MARINE AND NAVAL ENGINEERING.

Power Plants.

Gas Engines in Competition with Central Station Electric and Isolated Steam Plants. W. W. Cummings. Read before the Nat. Com. Gas Assn. Discussing matters of interest in developing the gas engine industry. Also general discussion. 8000 w. Pro Age—April 15, 1910. No. 13098.

See also Costs, under POWER AND TRANSMISSION.

Gas Producers.

Bituminous Gas Producers. Discussion of J. R. Bibbins' paper. 4000 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13244 F.

Testing Suction Gas Producers. Discussion of paper by C. M. Garland and A. P. Kratz. 5000 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13243 F.

Suction Gas Producers Using Peat as Fuel (Gasogeni ad Aspirazione per Torba fangosa). Ugo Giribaldi. Describes a number of installations, with data of results. Ills. 2000 w. Industria—March 6, 1910. No. 13346 D.

Oil Engines.

Some Experiments on a Diesel Engine. William Ernest Fisher, and Edmund Baddeley Wood. Describes experiments made with an engine of the Diesel type at various compressions, and with different fuels. Ills. 5000 w. Inst of Civ Engrs—(Students' paper. No. 629.) No. 13276 N.

Three-Years' Record From a Diesel Engine Plant. J. J. Wagoner. Gives results obtained in a 450-h.p. Diesel engine plant, which replaced a compound-engine belt-driven steam plant. 800 w. Power—April 19, 1910. No. 13183.

Danish Petroleum and Crude Oil Motors. Axel Holm. Drawings and description. Ills. 2000 w. Int Marine Engng—April, 1910. No. 12817 C.

Rating.

Commercial Ratings for Internal Combustion Engines. William D. Ennis. Gives an analysis of the factors limiting the output of an engine running under stated conditions. 1600 w. Mach, N Y—April, 1910. No. 12891 C.

HEATING AND COOLING.

Central Plants.

Two Types of Central Heating Plant Compared. Analyzes forced-circulation, hot-water and vacuum steam heating for central plants. 2000 w. Met Work—April 9, 1910. No. 13012.

Refrigeration.

Ice-Making from Exhaust Steam. Illustrates and describes methods used at the plant of the Holdrege, Neb., Lighting Co., which makes ice as a by-product of power generation. 3000 w. Elec Wld—April 7, 1910. No. 12992.

Steam Heating.

A Vapor Vacuum System of Heating. Describes an example of this system. Ills. 2000 w. Met Work—April 9, 1910. No. 13011.

See Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Ventilation.

The Ventilation of Court Rooms and Halls of Justice. William J. Baldwin. Discusses the conditions that prevail and the ventilation necessary. 2000 w. Heat & Vent Mag—April, 1910. No. 13543.

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HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Design, Construction and Operation of High-Lift Centrifugal Pumps. Frank zur Nedden. This fifth and concluding part of a serial considers special high-lift turbo-pumps and their relative economy. Ills. 2000 w. Engineering Magazine—May, 1910. No. 13591 B.

Balanced Multistage Turbo Pumps. Illustrated description of pumps made by the British Electric Plant Co., Ltd. 1600 w. Ir & Coal Trds Rev—April 8, 1910. No. 13178 A.

Turbine Pump in the Low Level Pumping Station, Montreal, Que. A report of the official test. Ills. 1500 w. Can Engr—April 8, 1910. No. 13018.

Compressed-Air Pumping.

Yorkton Compressed Air Water-Works System. F. T. McArthur. Sketches and description of this plant in Canada. 700 w. Can Engr—April 15, 1910. No. 13127.

Design.

Hydraulic Machinery and Appliances. A. Etchells. Read before the Manchester Assn. of Engrs. Remarks on the application of water to mechanical work, and illustrated descriptions of appliances used. 2500 w. Mech Engr—April 8, 1910. Serial. 1st part. No. 13162 A.

Electric Pumping.

Hydroelectric Power as Applied to Irrigation. John Coffee Hays. Considers some of the operating conditions encountered in electrically pumping water for irrigation, describing a typical system. 7000 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13235 F.

Electric Irrigation Pumping in Colorado. E. C. Reybold, Jr. Explains its effect on the summer load curve of the Northern Colorado Power Co. Ills. 2500 w. Elec Wld—April 7, 1910. No. 12991.

Irrigation Pumping. E. C. Reybold, Jr. Reports rates charged for electric service in Colorado. 1800 w. Elec Wld—April 28, 1910. No. 13562.

An Electrohydraulic Pumping Plant. W. A. Clatworthy. From a paper before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrated description of a plant to provide water power for operating various cranes, capstans, lock gates, bridges, etc., in connection with the docks at Bristol, Eng. 1500 w. Elec Rev, N Y—April 9, 1910. Serial. 1st part. No. 13004.

Hydraulic Pressure.

Some Curious Effects of Hydraulic Pressure. F. H. Stillman. Illustrates and describes hydraulic pressure valves cut by jet of water. 1200 w. Am Mach—Vol. 33. No. 15. No. 13085.

Pumping Plants.

See Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Purification, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Theory of Impulse Pumping and Construction of Pumps. John Richards. Illustrates and describes various forms of impulse pumps, discussing the theory. 2200 w. Am Mach—Vol. 33. No. 15. No. 13086.

Notes on the Design and Efficiency of Impulse Pumps. John Richards. Suggestions for reducing cost and increasing efficiency. Ills. 2400 w. Am Mach—Vol. 33. No. 16. No. 13249.

Calculations for the Size of a Pump Beam. Edward M. Bragg. Gives method of calculating the stresses. Mathematical. 1500 w. Int Marine Engng—April, 1910. No. 12816 C.

Turbine Losses.

The Resistance to Rotation of Disks in Water at High Speeds. Arnold Hartley Gibson and A. Ryan. An account of researches to determine the magnitude of the friction at speeds from 600 to 2200 revolutions per minute. Also investigates variation with temperature. 4500 w. Inst of Civ Engrs—No. 3862. No. 13274 N.

Turbine Plants.

See Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbines.

Four 9000-Horsepower Water Turbines. H. Birchard Taylor. Illustrates and describes construction features of the latest development in water turbines, and their increased efficiency and volume. 2500 w. Power—April 19, 1910. No. 13181.

Water Wheels.

The Testing of Water Wheels After Installation. C. M. Allen. Discusses the use of the Alden absorption dynamometer in making brake tests and compares results with computations from the Holyoke tests. Ills. 3500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13238 F.

MACHINE ELEMENTS AND DESIGN.

Crankshafts.

The Calculation of Crankshafts for Internal Combustion Engines. D. O. Barrett. Gives formulae for determining the diameters, sizes of bearings, and dimensions of cheeks. 900 w. Mach, N Y—April, 1910. No. 12892 C.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

Aluminium Gas Engine Cylinders. Illustrates and describes the method of their production and discusses how the shrinkage problem was overcome. 1200 w. Foundry—April, 1910. No. 12913.

Making Gas Engine Cylinders in Aluminum. Illustrates and describes the method of production. 1500 w. Ir Trd Rev—March 31, 1910. No. 12807.

Automatic Machines.

Davenport Multi-spindle Automatic Screw Machine. Illustrated detailed description

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of the general features. 2500 w. Am Mach—Vol. 33. No. 15. No. 13081.

Boring.

Some Work Performed on Huge 60-foot Boring Mill. Robert Reid. Illustrates and describes a variety of operations on extra large work. 1000 w. Am Mach—Vol. 33. No. 16. No. 13246.

Brass Founding.

The Chemist in the Brass Foundry. W. M. Corse. Read before the Am. Chem. Soc. On the development of the chemical laboratory in connection with brass foundries. 1200 w. Brass Wld—April, 1910. No. 13430.

Equipment of a Modern Brass Shop. C. Vickers. The construction and general arrangement is illustrated and described, including a description of novel tilting oil furnaces and ladle heaters. 3500 w. Foundry—April, 1910. No. 12916.

Case Hardening.

On Practical Methods of Casehardening. E. R. Markham. Considers various examples. 2500 w. Mech Wld—April 1, 1910. No. 13053 A.

Castings.

"Casting-On" Liners on Iron Pump Rams, Etc. Walter J. May. Describes the work. 800 w. Mech Wld—April 8, 1910. No. 13163 A.

Cupola Practice.

Cupola Practice (Kupolofen-Betrieb). A. Koob. A general review of practical points in cupola operation. 3000 w. Giesserei-Zeit—March 15, 1910. No. 13366 D.

Air Supply in the Design and Operation of Cupola (Die Luftmenge und ihre Bedeutung für den Bau und Betrieb der Kupolofen). Georg Buzek. An exhaustive discussion of the problem of air-supply in cupola practice. Ills. Serial. 1st part. 6500 w. Stahl u Eisen—March 2, 1910. No. 13354 D.

Cutting Metals.

The Cutting of Metals by Oxidation. James Aston. Considers cutting by the oxyhydrogen or oxyacetylene blow pipe. 2000 w. Wis Engr—April, 1910. No. 13198 D.

Drilling Machines.

High-Speed Universal Radial Drilling Machine. Illustrated description of a design manufactured in England. 800 w. Mech Engr—April 8, 1910. No. 13161 A.

Forging Hammers.

Electrically Driven Drop Hammers. Illustrated detailed description of new designs and their operation. 2000 w. Engr, Lond—March 25, 1910. No. 12941 A.

Foundries.

See Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Foundry Coke.

Coke for Foundry Purposes. E. L. Rhead. Read before the British Found. Assn. Discusses the qualities required to secure the best results. 1500 w. Prac Engr—April 1, 1910. No. 13048 A.

Foundry Design.

Fire Prevention in Foundries. Sidney G. Walker. Presents the advantages of the sprinkler system and proper plant construction. 4500 w. Foundry—April, 1910. No. 12914.

Grinding.

Cam Grinding. H. T. Shearer. Illustrated description of new grinding equipment. 1500 w. Ir Trd Rev—March 31, 1910. No. 12808.

Lathes.

A Large Sliding, Surfacing and Boring Lathe. Illustrated description of a large lathe designed for dealing with all kinds of heavy forgings and steel castings. 1000 w. Engr, Lond—April 15, 1910. No. 13469 A.

102-In. Surfacing and Screw-Cutting Lathe. Illustrated description of an unusually large lathe. Plate. 8000 w. Engng—March 25, 1910. No. 12935 A.

Turret Lathe with Ball Bearings. Illustrated description of a 10½-inch centres turret lathe, with report of tests. 1200 w. Engr, Lond—April 15, 1910. No. 13471 A.

Speed-Changing Gears (Ueber die Wirtschaft des Radabdrehens). Herr Lamm. A discussion of progress in this field. Ills. Serial. 1st part. 1700 w. Glasers Ann—March 1, 1910. No. 13395 D.

Molding.

Plaster False Backs for Hand Molding. Walter J. May. Describes these devices and their use. Ills. 800 w. Mech Wld—April 1, 1910. No. 13052 A.

Planing Machines.

The Work of Planing Machines (Note sur le Travail des Raboteuses). E. Gueneau. A mathematical discussion of their power requirements. 3000 w. All Indus—March, 1910. No. 13330 D.

Screw Making.

Principles of Thread Rolling and the Setting of the Dies. J. F. Springer. Explains the action of a thread rolling die, the setting of the die, and related processes. 2500 w. Am Mach—Vol. 33. No. 16. No. 13250.

Shop Appliances.

Fixtures for Machining Eccentric Piston Rings. C. T. Schaefer. Illustrations and brief description. 700 w. Mach, N Y—April, 1910. No. 12896 C.

Shop Design.

Some Serious Defects of Machine Shop Construction and Equipment. Oscar E. Perrigo. Calls attention to some of the faults observed and curious arrangements. 3000 w. Ir Trd Rev—April 7, 1910. No. 12972.

Light, Ventilation and Drainage in One-Story Shop Design. Drawings and description of two designs, adapted to climatic conditions in the north. 1600 w. Mach, N Y—April, 1910. No. 12893 C.

We supply copies of these articles. See page 479.

Shop Heating.

A Modern Shop-Heating System (Eine moderne Fabrikheizung). Max Hottinger. Describes the steam-heating system of a large German works. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—March 26, 1910. No. 13515 D.

Shop Lighting.

Machine Shop Lighting. E. B. Rowe. An illustrated study of general shop illumination and the local lighting of machines. 1200 w. Ir Age—April 21, 1910 No. 13280.

Shop Practice.

The Influence of Improved Materials and Methods of Production on Shop Practice (Einfluss der Verbesserung des Materials—Eisen—und der Herstellverfahren auf den Fabrikbetrieb). C. Prinz. A general review of improvements in the metal-working field. Ills. 6000 w. Zeitschr d Ver Deutscher Ing—March 19, 1910. No. 13512 D.

The Manufacture of Wheels and Axles for Railway Rolling Stock. Illustrates and describes the process of manufacture. 1200 w. Mech Wld—March 25, 1910. Serial. 1st part. No. 12932 A.

Machining Gas Engine Flywheels, Cylinders and Beds. Ethan Viall. The practice of the Foos Gas Engine Co., at Springfield, O., is illustrated and described. 1500 w. Mach, N Y—April, 1910. No. 12895 C.

Special Tools and Methods Used in a Planer Building Shop. Illustrates and describes processes and devices used to advantage in a Cincinnati shop. 1500 w. Am Mach—Vol. 33. No. 14. No. 12952.

Automobile Building Details That Produce Good Results. Illustrates and describes modern practice in milling, grinding, boring, broaching, and turning operations. 2000 w. Am Mach—Vol. 33. No. 14. No. 12950.

Some of the Methods Used in Building the Locomobile. Fred H. Colvin. Illustrates and describes fixtures and tools for handling the various parts. 2500 w. Am Mach—Vol. 33. No. 17. No. 13552.

Advanced Methods Obtain in the National Plant. Thomas J. Fay. Illustrates and describes methods employed in manufacturing the National motor vehicles. 1500 w. Automobile—April 14, 1910. No. 13113.

Shop Kinks from the Elizabethport Shops of the Central Railroad of New Jersey. F. E. Lister. Descriptions with 44 illustrations. 8500 w. Ry Age Gaz—April 1, 1910. No. 12886.

Tempering.

The Tempering of Steel. William Manktelow. Considers temperatures of fusible alloys suitable for tempering steel. 800 w. Prac Engr—March 25, 1910. No. 12926 A.

Gear Hardening Practice at the Light Mfg. and Foundry Co. Information concerning the making of chrome-nickel steel gears. Ills. 1000 w. Am Mach—Vol. 33. No. 16. No. 13248.

Welding.

The Autogenous Welding of Metals. Illustrated review of the development of this process. 3000 w. Ir Trd Rev—April 14, 1910. No. 13117.

Some Recent Boiler Repairs by the Oxy-Acetylene Process. Successful applications of this process are illustrated and described. 1500 w. Boiler Maker—April, 1910. No. 12977.

Autogenous Welding (Observations sur la Soudure autogène). A letter from A. Le Chatelier criticizing Ch. Fremont's paper in *Génie Civil* for Feb. 28, 1910, with M. Fremont's reply. 2200 w. Génie Civil—March 19, 1910. No. 13339 D.

Wire Drawing.

The Humphrey Wire Drawing Machine. Illustrated description. The special features are its friction clutch, die threading device, wire block construction and the provisions for the safety of the operator. 3000 w. Ir Age—April 28, 1910. No. 13565.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

Special Steels. Leon Guillet. Read at fifth congress of Int. Assn. for Test. Mat. Reviews recent progress and the steels of importance for structural purposes. 2000 w. Mech Engr—April 1, 1910. No. 13051 A.

Report on the Question of the Use of Steel. Special Steels (Subject V, Littera B, for Discussion at the Eighth Session of the Railway Congress). R. L. Ettenger. Considers the use of special steel of high resistance in the making of the various parts of locomotives and rolling stock in America. Ills. 2800 w. Bul Int Ry Cong—March, 1910. No. 13485 G.

Cast Iron.

The Composition and Manufacture of Malleable Cast Iron (Sur la Composition et la Fabrication de la Fonte Malléable). R. Namias. From *Rassegna Mineraria.* Serial. 1st part. 1300 w. Métallurgie—March 23, 1910. No. 13333 D.

Metallography.

Segregation in Steel Castings. S. S. Knight. Discusses the value of microscopy and synthetic chemistry in metallographic investigations. 4000 w. Foundry—April, 1910. No. 12915.

Metallographic Investigation of a Skip Bale (Metallographische Materialuntersuchung eines Kübelbügels). H. Winter. Describes an investigation of a bale which failed in service. Ills. 1500 w. Glückauf—March 5, 1910. No. 13372 D.

See also Steel, under MATERIALS OF CONSTRUCTION.

Metal Shrinkage.

The Shrinkage of Metals and Alloys. From an article by Prof. F. Wuest in *Metallurgie.* Describes an ingenious meth-

od of accurate measurement, giving tabulated results with various non-ferrous groups. 1000 w. Ir Age—April 7, 1910. No. 12945.

Refractory Materials.

See same title, under MINING AND METALLURGY, MISCELLANY.

Steel.

Oxygen, Hydrogen and Nitrogen in Steel. E. F. Lake. Gives results of tests showing the effect of oxygen on blistering. 1500 w. Am Mach—Vol. 33. No. 14. No. 12951.

The Brittleness of Mild Steel Due to Nitrogen. C. E. Stromeyer. Read before the Inst. of Naval Archts. A report of experimental investigations with mill steel plates to ascertain whether any mechanical tests could be relied on to determine quality. 2500 w. Ir & Coal Trds Rev—March 25, 1910. No. 12942 A.

Some Remarks Upon the Critical Points of Steel, Their Method of Determination and the Value of Same. George W. Sargent. An illustrated article considering methods of determining these critical points, and giving a study of cooling curves and heating curves. 2000 w. Jour Fr Inst—April, 1910. No. 13533 D.

The Action of Steam on Iron. J. Newton Friend. Gives results of experiments and discusses their value. Ills. 3500 w. Jour W of Scotland Ir & St Inst—Dec. 17, 1910. No. 13531 N.

The Behavior of Ductile Material Under Torsional Strain with Restoration of Elasticity at Low Temperatures. Charles Edward Larard. A detailed account of experiments made to investigate behavior. 3500 w. Inst of Civ Engrs—No. 3848. No. 13275 N.

The Influence of Sudden Changes of Temperature on Mild Steel (Recherches sur l'Influence des brusques Changements de Température sur l'Acier doux). Bruno Zschokke. A report of experimental researches. Ills. 6200 w. Rev de Métal—March, 1910. No. 13316 E + F.

Tool Steel.

High Speed Steel and Its Heat Treatment. W. G. Smith. Extracts from an article in *The Armour Engr.* Explains the influence of various elements and the effects of treatment. 2200 w. Eng News—April 21, 1910. No. 13258.

Unusual Results Obtained by the Use of High Speed Steel. C. Berg. Gives report of a series of tests to determine its exact cutting capabilities under certain conditions. 2000 w. Am Mach—Vol. 33. No. 15. No. 13082.

MEASUREMENT.

Dynamometers.

The Measurement of Power: a New Transmission Dynamometer (La Mesure des Puissances: un nouveau Dynamomètre de Transmission). A. Bocquet. Describes the invention of M. André Wallon. Ills. 2000 w. Rev d'Econ Indus—March 20, 1910. No. 13301 D.

See also Water Wheels, under HYDRAULIC MACHINERY.

Gas Meters.

An Electric Gas Meter. Discussion of Carl C. Thomas's paper on this subject. 2500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13240 F.

Hardness.

Amsler Hardness Testing Machine and Cone Attachment. Illustrated description of a machine manufactured in Switzerland, for testing by the Brinell ball method; and an appliance for employing the Ludwik cone method. 900 w. Am Mach—Vol. 33. No. 15. No. 13083.

Laboratories.

Notes On Some European Testing Laboratories. An account by an engineer based on inspection of the laboratories of the technical high schools at Zurich, Stuttgart, Munich, Dresden, and the laboratory at Gros-Lichterfelde near Berlin. 2000 w. Eng News—April 28, 1910. No. 13570.

Testing Methods.

Lecture on "Some Points Regarding the Testing of Iron and Steel." Archibald Barr. Considers tensile tests of iron and steel. Ills. 8000 w. Jour W of Scotland Ir & St Inst—Oct. 22, 1909. No. 13529 N.

POWER AND TRANSMISSION.

Air Compressors.

Application of Low-Pressure Steam Turbines to Compressor Work. J. W. Sheperdson. Gives original output and economy data from a working installation. 3000 w. Engineering Magazine—May, 1910. No. 13594 B.

Cobalt Hydraulic Air Compressor. C. H. Taylor. Illustrated description of the Taylor air-compression system at Ragged Chutes, on the Montreal River, Canada. 2500 w. Mines & Min—April, 1910. No. 12863 C.

A Comparison Between a Piston Compressor and a Turbo-Compressor (Comparaison entre un Compresseur à Pistons et un Turbo-Compresseur). A review of Havlick's paper in the *Zeitschrift des Vereines Deutscher Ingenieure.* Ills. Serial. 1st part. 1800 w. Rev Indus—March 5, 1910. No. 13331 D.

Recent Borsig Air Compressors (Neuere Luftkompressoren der Maschinenfabrik A. Borsig). Herr Schwanecke. Describes a number of improvements and recent machines. Ills. 3700 w. Glückauf—March 26, 1910. No. 13378 D.

Belting.

A Systematic Solution of the Belting Problem. William H. Taylor. Illustrated description of an improved belt bench arranged to determine the length and weigh the tension in belts, with directions for using. Also remarks on the care of belting. 4500 w. Am Mach—Vol. 33. No. 17. No. 13551.

We supply copies of these articles. See page 479.

The Transmission of Power by Belts. R. Krall. Abstract of a paper read at meeting of Inst. of Engrs. Considers details of belt drives, and gives some results of experiments with steel belts in the present number. 1800 w. Prac Engr—April 1, 1910. Serial. 1st part. No. 13046 A.

Compressed Air.

Engine Driving by Compressed Air. Snowden B. Redfield. A theoretical study of a system in which current from a long distance transmission line drives a motor operated compressor supplying the engine with air which is reheated on its way to the cylinder. 4000 w. Power—April 5, 1910. No. 12910.

Costs.

Cost of Power for Various Industries Under Ordinary Conditions. Charles T. Main and F. M. Gunby. Explains some of the reasons for the very great differences in the cost of power under various circumstances. 6500 w. Jour Assn of Engng Socs—March, 1910. No. 13526 C.

A Practical Study of Power Costs. William O. Webber. Gives a report showing how actual costs were determined. 2000 w. Engineering Magazine—May, 1910. No. 13593 B.

Operating Costs of a Gas Power Plant and a Mixed Steam Engine and Turbine Plant (Betriebskosten einer Gas- und einer aus Kolbenmaschinen und Dampfturbinen gemischten Dampfkraftanlage). W. Heym. A comparison of the two types. Ills. 2500 w. Die Turbine—March 5, 1910. No. 13382 D.

Electric Driving.

Economical Features of Electric Motor Applications. Charles Robbins. Shows how a problem in motor drive can be handled in order to show its maximum economy. 11000 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13245 F.

Mechanical Features of Electric Driving in Machine Shops. John Riddell. Deals especially with the electrical equipment of machine tools in the plant of the General Electric Co., at Schenectady, N. Y. Ills. 2500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13239 F.

Electric Drive in Textile Mills. Albert Milmow. Deals especially with the employment of electric power, derived from hydroelectric systems of distribution, for the operation of textile mills, giving a series of curves taken with a delicate recording tachometer. 3500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13230 F.

The Driving of Textile Factories. A Comparison Between Electric and Steam Rope-Driving. L. Crouch. 5000 w. Elec Rev, Lond—April 15, 1910. No. 13455 A.

Electric Individual Drive in Continental Textile Mills. W. R. Rothenberg. Illustrated description of plant and equipment of all machines on the single-drive system. 2500 w. Elec Rev, Lond—April 15, 1910. Serial. 1st part. No. 13456 A.

See also Cranes, under TRANSPORTING AND CONVEYYING.

Gas Power.

See Gas Power Plants, under COMBUSTION MOTORS.

Lubricants.

Graphite as a Lubricant. Illustrated description of a graphite lubricator, manufactured in England. 1500 w. Engr, Lond—April 15, 1910. No. 13468 A.

Mechanical Power.

The Influence of Mechanical Power. Charles Edward Lucke. Abstract of last Hewitt lecture, at Cooper Union. Discusses its effect on present-day conditions. 1800 w. Power—April 12, 1910. No. 13029.

Piping Systems.

Identification of Piping Systems by Means of Colors (Die Kennzeichnung von Rohrleitungen im Fabrikbetriebe mittels Farben). Gives a chart of colors, suggesting additions to the scheme proposed by W. H. Bryan. Ills. 2000 w. Stahl u Eisen—March 9, 1910. No. 13355 D.

STEAM ENGINEERING.

Boiler Corrosion.

Boiler Corrosion. A study of electrochemical action with remarks on the experiments carried out by Prof. C. F. Burgess. 2500 w. Sci Am Sup—April 23, 1910. No. 13268.

Boiler Design.

Something About Boiler Stress Formulas. Charles J. Mason. Explains the more important formulae in use. 700 w. Boiler Maker—April, 1910. No. 12978.

Boiler Fittings.

Boiler Attachments and Funnel Draft. H. K. Spencer. Suggestions relating to attachments necessary to the operation of boilers, and a study of combustion and draft. 3500 w. Boiler Maker—April, 1910. No. 12979.

Boiler Furnaces.

A Smokeless Soft Coal Furnace. T. T. Parker. Illustrates a type of furnace for horizontal tubular boilers which has successfully prevented smoke. 1000 w. Power—April 19, 1910. No. 13185.

Boiler Management.

Combustion of Coal. Lewis Sanders. Discusses how to burn coal economically, and explains the use of the Orsat apparatus for ascertaining the amount of CO_2 in the flue gases. 3500 w. Jour U S Art—March-April, 1910. Serial. 1st part. No. 13288 D.

Boiler Repairs.

See Welding, under MACHINE WORKS AND FOUNDRIES.

Condensers.

Condensing. W. H. Booth. Brief discussion of condensers and present practice. 1200 w. Elec Rev, Lond—April 8, 1910. No. 13155 A.

We supply copies of these articles. See page 479.

Condenser Tubes and Circulating Water. Nathan Owitz. States briefly the advantages claimed for various types of condenser tubes, discussing also methods of cleaning. 1500 w. Power—April 12, 1910. No. 13027.

English Practice in Condensing Equipment. James A. Seager. Describes and illustrates the Leblanc system, air and circulating pumps of recent design, and systems of electric drives for condenser auxiliaries. 3000 w. Power—April 19, 1910. No. 13184.

English Practice in Condensing Equipment. James A. Seager. Illustrates and describes the contraflo condenser, the Parsons vacuum augmenter, and recent developments in the jet condenser of different types. 2500 w. Power—April 5, 1910. No. 12912.

Economizers.

See Feed-Water Heaters, under STEAM ENGINEERING.

Engine Economy.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Engine Erection.

The Erecting and Testing of a High-Speed Engine. W. S. Douglas. Prize paper. Considers the round of operations in erecting and testing. Ills. 2600 w. Mech Wld—April 15, 1910. Serial. 1st part. No. 13442 A.

Engine Governing.

Governing Rolling Mill Engines. Discussion of W. P. Caine's paper. 2500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13241 F.

Engines.

1500-Brake-Horse-Power High-Speed Steam-Engines. Plates and description of the engines for a power-house at Bahia Blanca, Argentina, for the Buenos Aires and Pacific Ry Co. 1500 w. Engng—March 25, 1910. No. 12937 A.

Engine Testing.

See Engine Erection, under STEAM ENGINEERING.

Feed Water Heating.

Feed Water Heaters and Economizers. William F. Fischer. Discusses the effect of oil and scale forming matter in open heaters; the live-steam feed-water heaters and purifiers, and the saving from using economizers. 1800 w. Power—April 26, 1910. No. 13476.

Feed Water Heaters of the Closed Type. William F. Fischer. Gives saving due to heating feed water by exhaust steam in closed heaters, and effect of scale and oil. 3000 w. Power—April 19, 1910. No. 13180.

Flue Gas Analysis.

See Boiler Management, under STEAM ENGINEERING.

Fuel Purchasing.

The Purchase of Coal for the Department of Water Supply, Gas and Electricity of New York City. J. Leggett Pultz. Including a description and criticism of several forms of coal contracts and specifications, the coal consumption of the city departments, and a proposed uniform and systematic method of purchasing coal. 13000 w. Dept of Water Supply, N Y—April, 1910. No. 13269 N.

Fuels.

Unit Coal and the Composition of Coal Ash. S. W. Parr and W. F. Wheeler. Presents results of investigations upon the properties of actual coal as distinguished from the mineral constituents. 11500 w. Univ of Ill, Bul No. 37—Aug. 9, 1909. No. 12959 N.

Fuel Oil. E. N. Percy. Deals with the extent of the world's supply and its effect on cost as compared with coal. 3000 w. Int Marine Engng—April, 1910. Serial. 1st part. No. 12819 C.

See also Coke-Oven Gas, under MINING AND METALLURGY, COAL AND COKE.

Smoke Prevention.

Smoke Prevention in Steam Boiler Plants. H. D. Frary. (Second article.) Illustrates and describes special methods and appliances for preventing smoke, and discusses conditions in large cities. 6000 w. Minn Engr—March, 1910. No. 13076 C.

Superheating.

The Effect of Superheated Steam on Cast Iron and Steel. Albert A. Cary. Calls attention to precautions necessary in installations. 2500 w. Ir Age—April 7, 1910. No. 12946.

Turbine Nozzles.

Efficiency Tests of Steam Nozzles. Discussion of paper by F. H. Sibley and T. S. Kemble. 4500 w. Jour Am Soc of Mech Engrs—April, 1910. No. 13242 F.

Turbine Plants.

Plant of Pfister & Vogel Leather Co. Osborn Monnett. Illustrates and describes a modern turbine plant designed for limited space and economical operation. 2000 w. Power—April 5, 1910. No. 12909.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Turbines.

The Relation of the Steam Turbine to Modern Central Station Practice. G. R. Parker. Reviews steam turbine principles, especially considering the Curtis impulse turbine as perfected by Emmet. General discussion. 8000 w. Jour Assn of Engng Socs—Feb., 1910. No. 12962 C.

The Oerlikon Series-Parallel Steam Turbine (Die Oerlikon-Serie-Parallel-dampfturbine). W. Koeniger. Describes a turbine for use with either live or exhaust steam. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13384 D.

We supply copies of these articles. See page 479.

Recent Eyermann Steam Turbines (Neuere Eyermann-Dampfturbinen). Describes and illustrates recent examples of this type of turbine. 1800 w. Zeitschr f d Gesamte Turbinenwesen—March 20, 1910. No. 13387 D.

See also Air Compressors, under POWER AND TRANSMISSION.

Valve Setting.

Setting Link Driven Valves. Warren O. Rogers. Explains the setting of slide valves of hoisting engines driven by link motion and two eccentrics. Ills. 2500 w. Power—April 12, 1910. No. 13025.

TRANSPORTING AND CONVEYING.

Coal Handling.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Cranes.

An Old-Time Crane. F. G. Haldy. Brief illustrated description of an old treadmill crane at Treves, Germany. 500 w. Cassier's Mag—April, 1910. No. 13195 B.

The Crane Equipment of the Hamburg Branch of the Vulcan Works, Stettin (Die Hellinganlage des Stettiner Vulcan, Zweigniederlassung Hamburg). A. Cyran. Detailed description. Ills. Serial. 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—March 5, 1910. No. 13508 D.

Electric Driving of Machines of Intermittent Operation, with Particular Reference to Cranes (Note sull' Azionamento elettrico delle Macchine a Funzionamento intermittente ed in Particolare delle Gru). E. Sacerdote. Discusses the choice of motors for this service. Ills. 3800 w. Ann d Soc d Ing e d Arch Ital—March 1, 1910. No. 13345 F.

Elevators.

The Elevator Installation of the Metropolitan Life Tower. Herbert T. Wade. Illustrated detailed description of the Otis system as installed in a 44-story building. 1500 w. Sci Am—April 30, 1910. No. 13574.

Grain Handling.

See Grain Elevators, under MARINE AND NAVAL ENGINEERING.

Lifting Magnets.

Lifting Magnets in the Foundry. A. C. Eastwood. Abstract of a paper read before the Pittsburg Found. Assn. Illustrates and describes a number of applications. 3000 w. Ir Trd Rev—April 21, 1910. No. 13289.

MISCELLANY.

Aerodynamics.

The Installation of an Aerodynamic Laboratory (Installation d'un Laboratoire d'Aérodynamique). M. G. Eiffel. Describes a laboratory equipped by the author for the study of air resistance, the methods of experiment, and results obtained. Ills. 11500 w. Mem Soc Ing Civ de France—Jan., 1910. No. 13304 G.

Aeronautics.

Motive Flying Machines (Motor-Flugmaschinen). Johann Trnovsky. A review of the leading types of airships and aeroplanes. Ills. 8500 w. Oest Wochenschr f d Oeffent Baudienst—March 5, 1910. No. 13500 D.

Aviation (L'Aviation). Commandant Paul Renard. The first part of the serial discusses the fundamental principles of aeronautics. Serial. 1st part. 11000 w. Rev Gen des Sci—March 15, 1910. No. 13319 D.

Longitudinal Equilibrium and Curvature of Aeroplane Planes (L'Equilibre longitudinal et la Courbure des Surfaces portantes des Aéroplanes). René Arnoux. A theoretical discussion. Ills. 6500 w. Mem Soc Ing Civ de France—Jan., 1910. No. 13305 G.

Aeronautic Progress Along Constructive Lines. Marius C. Krarup. The first of a series of articles discussing aeronautic construction. 1000 w. Automobile—April 14, 1910. Serial. 1st part. No. 13115.

The Construction of Aeroplanes. The present article gives an illustrated description of the latest Farman biplane. 2500 w. Engr, Lond—April 8, 1910. Serial. 1st part. No. 13171 A.

The Military Aspect of Dirigible Balloons and Aeroplanes. J. E. Capper. Reviews briefly the progress made and probable developments, discussing how best to utilize these machines. Discussion. 3500 w. Jour U S Art—March-April, 1910. No. 13285 D.

A Possible Use for Aeroplanes in War Suggested by Witnessing Their Flight at Los Angeles. S. F. Bottoms. Discusses their use for dropping high explosives on hostile forts or armies in the field. 600 w. Jour U. S Art—March-April, 1910. No. 13283 D.

The Wright Flyer and Its Possible Uses in War. F. E. Humphreys. Considers the uses from a military stanpoint. Ills. 2000 w. Jour U S Art—March-April, 1910. No. 13284 D.

The Olympia Aero Exhibition. W. S. Aston. Illustrated description of the show and some of the notable exhibits. 2000 w. Sci Am Sup—April 9, 1910. No. 12984.

The First Aviation Meet in America. Leroy W. Allison. A record of the performances and an illustrated description of the machines. 3800 w. Mach, N Y—April, 1910. No. 12899 C.

Bread Making.

Bread Making by Machinery (La Panification mécanique). L. Ammann. Discusses the hygienic importance of the employment of machinery in bread making and describes various machines. Ills. 5000 w. Bul Soc d'Encour—Feb., 1910. No. 13318 G.

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Guns.

The Life and Power of Heavy Ordnance. Editorial reply to criticisms of an earlier article on the efficiency of guns and matters related. 3000 w. Engng—April 15, 1910. No. 13465 A.

Airship Guns. Illustrates and describes guns developed by Krupps and by the Ehrhardts to contend against airships. 1000 w. Jour U. S. Art—March-April, 1910. No. 13286 D.

Safety Devices.

The Protection of Employees in Cotton Mills. H. M. Crawford. Illustrates and describes methods of fencing self-acting mules. 2500 w. Cassier's Mag—April, 1910. No. 13193 B.

Textile Machinery.

Calico Printing Mechanism. James Robinson. Reviews the mechanism employed in a modern calico printing works. Ills. 18500 w. Manchester Assn of Engrs. (Adv Copy)—March 12, 1910. No. 13491 N.

Weaving Appliances. Frank Nasmith. Read before the Manchester Assn. of Engrs. Describes the essential operative mechanisms, and appliances for the purpose of increasing production. Ills. 1600 w. Mech Engr—March 25, 1910. Serial. 1st part. No. 12931 A.

See also Safety Devices, under MISCELLANY.

Textile Mills.

A Modern Cotton Mill. An illustrated detailed description of one of the latest Lancashire factories, giving a description of the lay-out and arrangement of the various departments, and describing appliances of special interest. 2500 w. Engr, Lond—April 8, 1910. Serial. 1st part. No. 13169.

See also Electric Driving, under POWER AND TRANSMISSION.

MINING AND METALLURGY.

COAL AND COKE.

Alaska.

The Alaska Coal Cases. H. V. Winchell. A statement of facts relating to the Cunningham claims in Alaska, and discussion of the attitude of the U. S. Government in regard to their development. 4500 w. Eng & Min Jour—April 23, 1910. No. 13414.

The Controller Bay Coal Field. George Watkin Evans. An estimate of the amount, cost of mining and probable market of coal in this field. Map and Ills. 4000 w. Mines & Min—April, 1910. No. 12867 C.

Australia.

The Geology of Victoria Coal Deposits. T. S. Hart. Presents a "modified drift theory" to explain the Powlett field deposits. 2000 w. Aust Min Stand—March 16, 1910. Serial. 1st part. No. 13487 B.

The Coal Mining Industry of Victoria. An illustrated account of the official opening of the Powlett field, with history of the enterprise. 4000 w. Aust Min Stand—March 16, 1910. No. 13486 B.

Briquetting.

The Fuel-Briquetting Industry. Charles L. Wright. An illustrated article giving a classification of fuel dryers and briquetting machines. 2200 w. Engineering Magazine—May, 1910. No. 13590 B.

Coke-Oven Gas.

The Use of Coke-Oven Gas as Fuel. Thomas J. Brown. Read before the Min. Soc. of Nova Scotia. Gives details of the plant of the Nova Scotia Steel & Coal Co., explaining how the waste gases were utilized as fuel. 2000 w. Can Min Jour—April 15, 1910. No. 13186.

Coking By-Products.

The Utilization of Germany's Natural Resources (Die Auswertung vaterländischer Bodenschätze). F. E. Junge. A discussion of the importance of by-product recovery in the utilization of coal. 4000 w. Tech u Wirt—March, 1910. No. 13521 D.

The Manufacture of Benzol (La Fabrication du Benzol). A. Grebel. Describes the process of recovery from coke-oven gas. Ills. 4500 w. Génie Civil—March 19, 1910. No. 13338 D.

Electric Power.

An Electrical Safety System for Use in Mines. H. J. Fisher. Illustrated description of a system to reduce the risks attending the use of trailing cables and portable electrically-driven machinery in mines. 2500 w. Elect'n, Lond—April 1, 1910. No. 13044 A.

The Relative Merits of Direct- and Three-Phase Alternating Currents for Colliery Work. C. R. M. Young. Read before the Newcastle Sec. of the Inst. of Min. Elec. Engrs. A comparison of their reliability cost, and flexibility. 4500 w. Ir & Coal Trds Rev—April 8, 1910. No. 13176 A.

Electrical Breakdown in Collieries: Their Cause and Prevention. H. J. Fisher. Read before the Newcastle Branch of the Inst. of Min. Elec. Engrs. Also discussion. Discusses faults on cables due to bad design, faulty operation, machinery, bad work and moisture. 7500 w. Ir & Coal Trds Rev—March 25, 1910. No. 12943 A.

The Electrification of Murton Colliery, County Durham. A descriptive account

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of the change from steam to electric power. 4000 w. Ir & Coal Trds Rev—April 15, 1910. No. 13474 A.

England.

See Boring, under MINING.

Explosions.

Mine Explosions at Stearns, Ky. Location and description of the mines, and of the peculiar action of the explosive force. Plans. 2200 w. Mines & Min—April, 1910. No. 12870 C.

France.

The Lorraine Coal Basin (Le Bassin houiller de la Lorraine). Gabriel Sepulchre. A detailed report on its extent, importance, development, etc. Ills. 10000 w. Tech Mod—March, 1910. No. 13325 D.

Manchuria.

The Fushun Colliery, South Manchuria. Warden A. Moller. Brief description of sub-bituminous mines now being opened. 1000 w. Bul Am Inst of Min Engrs—April, 1910. No. 13539 F.

Mine Dust.

The Ignition of Coal Dust by Single Electric Flashes. Abstract of a paper by Dr. W. M. Thornton and E. Bowden, before the Inst. of Min. & Mech. Engrs. Discusses results of exhaustive experimental investigations. Discussion. 7000 w. Ir & Coal Trds Rev—April 15, 1910. No. 13473 A.

Mine Fires.

Mine Recovery with Oxygen Helmets. R. Y. Williams. Describes the recovery of the fire-sealed area of the Majestic mine. Ills. 2500 w. Min Wld—April 2, 1910. No. 12881.

Mine Waters.

The Clarification of Pit Effluent Waters. Brief description of methods used in the Westphalian mining district in Germany. 1000 w. Ir & Coal Trds Rev—April 1, 1910. No. 13064 A.

Mining.

Safe Methods of Coal Mining (Die für die Sicherheit der Arbeiter zweckmässigsten Arten des Ausbaues vor Abbauen und der Flözverhiebes beim Steinkohlenbergbau). Dr. Niess. The first part discusses the prevention of falls of roof and coal. Ills. Serial. 1st part. 4500 w. Glückauf—March 19, 1910. No. 13376 D.

Advance and Retreat Room—and—Pillar System. H. J. Nelms. Describes a plan for developing a coal mine on this system. 700 w. Eng & Min Jour—April 23, 1910. No. 13418.

Mining Thick Seams in the Ruhr District (Der Abbau besonders mächtiger Flöze im Ruhrbezirk). Herr Unterhössel. Illustrated description of methods. 4000 w. Glückauf—March 5, 1910. No. 13370 D.

Mining Thick Seams in the St. Etienne Basin (Der Abbau besonders mächtiger Flöze im Becken von Et. Etienne). Herr Unterhössel. Illustrated description of methods. 1600 w. Glückauf—March 5, 1910. No. 13371 D.

Mining Hygiene.

How European Collieries Are Safeguarded. An account of methods adopted to improve conditions and prevent disease, and precautions to eliminate explosions and increase efficiency. 3000 w. Eng & Min Jour—April 15, 1910. No. 13130.

Mining Royalties.

The Checking of Coal Royalty Accounts. R. Wilson Bartlett. Considers in their order the chief features met with in the usual form of mineral leases. 2800 w. Ir & Coal Trds Rev—April 1, 1910. No. 13062 A.

Mining Wages.

Wages in the German and British Mining Industries (Deutsche und britische Bergarbeiterlöhne). Ernst Jüngst. A statistical review, covering the last quarter-century. 4000 w. Glückauf—March 12, 1910. No. 13375 D.

Washing.

Coal Washing Plant. Illustrated description of a plant with patent conditioning draining machine. 1000 w. Ir & Coal Trds Rev—April 1, 1910. No. 13063 A.

Eliminating Dust from Anthracite Breaker. J. J. Jones. Describes a dust eliminator patented by B. G. Carpenter & Co., stating the advantages claimed. 1000 w. Eng & Min Jour—April 2, 1910. No. 12878.

COPPER.

Analysis.

Methods of Analysis at Cananea Con. Property. Evans W. Buskett. Gives the methods used in the routine analyses of slags, ores, bullion, etc., at the Ronquillo laboratory of the Cananea Consolidated Copper Co., S. A. 4000 w. Min Wld—April 2, 1910. No. 12882.

Arizona.

Courtland, Ariz., and Its Mining Possibilities. Charles A. Dinsmore. An illustrated article giving information concerning the condition of this copper camp. 2500 w. Min Wld—April 9, 1910. No. 13019.

Copper Deposits of the Globe-Kelvin Districts. Edwin Higgins. Describes the geology, the deposits, development work, etc., of districts in Arizona giving promise of valuable production. Maps & Ills. 2000 w. Eng & Min Jour—April 9, 1910. Serial. 1st part. No. 13007.

Australia.

Kyloe Copper Mine, Adaminaby (N. S. W.). Describes the mine and ore-dressing plant. Ills. 2500 w. Aust Min Stand—March 2, 1910. No. 13035 B.

Converters.

See Mattes, under COPPER.

Mattes.

The Behavior of Copper-Matte and Copper-Nickel Matte in the Bessemer Converter. David H. Browne. Gives re-

sults of experimental study and conclusions. Curves & tables. 2500 w. Bul Am Inst of Min Engrs—April, 1910. No. 13538 F.

Nevada.

Conditions in the Yerington Copper District. John Tyssowski. Map of principal mines of the district with statement of present conditions. 1500 w. Eng & Min Jour—April 9, 1910. No. 13005.

Refining.

The Electrolytic Process of Copper Refining. H. Schroder. Illustrates and describes Australian plants and process used. 2500 w. Aust Min Stand—Feb. 16, 1910. Serial. 1st part. No. 13033 B.

Reverberatory Furnaces.

Smelting Copper in Small Reverberatory Furnaces. Edwin M. Clark. Illustrates and describes a small reverberatory smelting furnace used in Mexico, giving results. 2000 w. Min & Sci Pr—April 23, 1910. No. 13585.

Theoretical Notes on Reverberatory Furnaces. C. A. Grabill. A comparison of results with different fuels. 3500 w. Eng & Min Jour—April 16, 1910. No. 13129.

Slags.

Notes on the Metal Losses in Copper Slags. C. A. Grabill. A study of physical and chemical losses and their causes. 2500 w. Eng & Min Jour—April 9, 1910. No. 13009.

Smelters.

The Granby Smelter Equipment. B. L. Sackett. Illustrates and describes the handling and treatment of the copper ore at this smelter in N. Dakota. 4500 w. Mines & Min—April, 1910. No. 12861 C.

The Washoe Reduction Works in 1909. An account of recent additions and improvements. Ills. 4000 w. Mines & Min—April, 1910. No. 12860 C.

The New International Smeltery at Toole, Utah. John Tyssowski. Illustrated description of the plant designed to smelt the Utah Consolidated and custom ores. 2200 w. Eng & Min Jour—April 23, 1910. No. 13415.

The Steptoe Smelting Plant, Nevada. Leroy A. Palmer. Illustrated detailed description of this plant. 4000 w. Min Wld—April 2, 1910. No. 12879.

The Cerro de Pasco Smelting Works, Peru. Lester W. Strauss. Trans. from *Bol. de la Direc. de Fomento.* Description of the largest installation of the kind in South America. Ills. 3500 w. Min Wld—April 2, 1910. No. 12883.

Washington.

The Northern Cascades. Horace F. Evans. Describes the geology of the Osoyoos basin in the state of Washington and gives the history of the discovery of copper deposits and their development. 1500 w. Min & Sci Pr—March 26, 1910. No. 12804.

GOLD AND SILVER.

Alaska.

See Placers, under GOLD AND SILVER.

Australia.

Some Geological Considerations Affecting Western Australian Ore-Deposits. A Montgomery. Abstract of paper read before the Aust. Inst. of Min. Engrs. Gives a résumé of the geological history and a statement of conclusions and deductions. 3500 w. Min Jour—April 16, 1910. No. 13441 A.

Cyaniding.

Extraction Percentages in Metallurgical Plants. H. A. Megraw. A discussion of the methods of calculating and explanation of a system. 2000 w. Eng & Min Jour—April 2, 1910. No. 12871.

Cyanidation of Silver-Gold Ores at Guanajuato. J. A. Reid. Abstract of paper read before the Min. Soc. of Nova Scotia. An account of the treatment of low-grade silver-gold ores by the cyanide process. 3500 w. Min Wld—April 9, 1910. No. 13022.

Mexico.

Alamos-Promonitos District. Map and description of this region in Mexico, which has yielded precious metals amounting to $100,000,000 in value. 900 w. Min & Sci Pr—April 16, 1910. No. 13291.

Nevada.

Kimberly, Nevada. Jay A. Carpenter. Illustrated description of this mine and its development. 1200 w. Min & Sci Pr—April 2, 1910. No. 12967.

Ontario.

Porcupine Gold Fields Being Actively Exploited. Alex. Gray. Information concerning this district and adjoining territory. 3500 w. Min Wld—April 9, 1910. No. 13021.

Oregon.

The North Pole Mine, Baker County, Oregon. Emil Melzer. An account of an important gold mine worked by tunnels. Section. 1500 w. Eng & Min Jour—April 23, 1910. No. 13416.

Placers.

The Innoko Placer District, Alaska. A. G. Maddern. Abstract from Bul. 240, U. S. Geol. Surv. Sketch map and account of the discovery of placer gold. 2000 w. Min Wld—April 16, 1910. No. 13145.

The Alluvial Gold Fields of Quebec. Alexander Gray. Gives the history of this area, and the present exploitation and development. 2500 w. Min Wld—April 16, 1910. No. 13144.

Quebec.

See Placers, under GOLD AND SILVER.

IRON AND STEEL.

Analysis.

Acid Open-Hearth Slag and Its Analysis. F. C. T. Daniels. Gives a method of analysis for silica, ferrous oxide, manganese oxide, ferric oxide and metallic

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iron. 2000 w. Ir Trd Rev—March 31, 1910. No. 12809.

Standardization of Permanganate Solutions in the Reinhardt Titration Method (Titerstellung von Kaliumpermanganatlösungen zur Eisentitration nach Reinhardt). Results of an experimental investigation. 2700 w. Stahl u Eisen—March 9, 1910. No. 13357 D.

Australia.

Two Important Iron Ore Deposits of Australia. J. Bowie Wilson. The deposits of Iron Island consists of hematite and magnetite; Koolan Island contains larger bodies. Ills. 1500 w. Eng & Min Jour—April 2, 1910. No. 12876.

Blast-Furnace Gas.

Possible Uses of Waste-Gas Power. I. V. Robinson. Abstract of a paper read before the W. of Scotland Ir. & Steel Inst. Deals only with waste gases from the blast furnace. 3000 w. Ir & Coal Trds Rev—April 8, 1910. No. 13177 A.

The Gas-Cleaning Plant of the Bethlen-Falvahütte in Schwientochlowitz, upper Silesia (Die Gasreinigungsanlage der Bethlen-Falvahütte in Schwientochlowitz, O.-S.). Fr. Berger. Illustrated description. 1800 w. Stahl u Eisen—March 16, 1910. No. 13361 D.

Blast-Furnace Plants.

The New Blast-Furnace at the Gutehoffnungshütte (Die neue Hochofenanlage der Gutehoffnungshütte). Fr. Frölich. Illustrated description. Plates. 1800 w. Stahl u Eisen—March 16, 1910. No. 13360 D.

Blast-Furnace Practice.

The Decomposition of Carbon Monoxide in Presence of Catalytic Agents and in the Blast Furnace. Fritz Zimmermann. Read before the N. Y. section of the Am. Elec. Chem. Soc. Studies and experiments of reactions in the blast furnace. 2500 w. Met & Chem Engng—April, 1910. No. 12798 C.

Calculation of Air Supply for Blast Furnaces (Berechnung der Windmenge für Hochöfen). Discusses and compares the results of three methods, based on the dimensions of the blower, the coke consumption, and the composition of the waste gases. 2500 w. Stahl u Eisen—March 23, 1910. No. 13364 D.

Blast Furnaces.

The New Plant of the Struthers Furnace Co. Illustrated description of the rebuilding and modernizing of a prominent Ohio furnace. 1200 w. Ir Trd Rev—April 14, 1910. No. 13116.

Canada.

Canadian Iron and Steel. Watson Griffin. Reviews the development of this industry. 1500 w. Can Min Jour—April 1, 1910. Serial. 1st part. No. 12949.

Iron and Steel Production in Canada. T. Good. A report of recent production and the importance of the industry. 2500 w. Cassier's Mag—April, 1910. No. 13192 B.

China.

The Tayeh Iron Mines. A. J. Seltzer. An account of mines in China, which have been worked since 1888, giving analyses of the ore and limestone, and the raw and finished products of the Hangyeng works. 2500 w. Min Sci Pr—April 16, 1910. No. 13290.

Electrometallurgy.

The Development of Electric Steel Plants (Zur Entwicklung der Elektrostahlanlagen). A list of the electric steel-furnace installations in all parts of the world, with data of capacity, power requirements, products, etc. 2500 w. Stahl u Eisen—March 23, 1910. No. 13363 D.

The Present Status of the Electric Steel Industry. From *Stahl und Eisen*. List of installations, in American and European works, with data as to the system employed, the capacity and character of the product. 1200 w. Ir Age—April 14, 1910. No. 13093.

Electricity in Iron and Steel Manufacture. A. S. Atkinson. Reviews results in Germany, Sweden and Norway, Canada and the United States. 2200 w. Ir Trd Rev—April 28, 1910. No. 13577.

The South Chicago Electric Furnace Plant of the United States Steel Corporation. Illustrated description and information relating to this Bessemer converter, electric furnace combination plant. 3000 w. Met & Chem Engng—April, 1910. No. 12797 C.

The Girod Electric Furnace and Metallurgical Works (Der Girod-Ofen und die elektrischen Schmelzwerke, System Paul Girod). W. Borchers. Describes particularly the Ugine plant. Ills. Serial. 1st part. 1500 w. Oest Zeitschr f Berg- u Hüttenwesen—March 19, 1910. No. 13369 D.

France.

The Briey Iron Ore Deposits in France. Gives the early history of these remarkable deposits, and general information. 1200 w. Ir Age—April 14, 1910. No. 13092.

Deposits of Iron Ore in the French Alps (Die Eisenerzvorkommen in der Fränkischen Alb). E. Holzapfel. A review of their extent and a description of the deposits. Ills. 6000 w. Glückauf—March 12, 1910. No. 13373 D.

Minnesota.

The Minnesota Iron Ranges. G. O. Virtue. Information concerning production, transportation facilities, conditions, labor, mining, wages, cost of living, and related matters. 19500 w. Bul Bureau of Labor—Sept., 1909. No. 13067 N.

Open-Hearth.

An Experimental Investigation of the Hoesch Process (Experimentelle Untersuchungen des Hoechverfahrens). Fr.

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Springorum. A report of an extended investigation of the utilization of heat in the process. Ills. 8700 w. Stahl u Eisen—March 9, 1910. No. 13356 D.

See also Analysis, under IRON AND STEEL.

Open-Hearth Furnaces.

Water Cooling Devices for Open Hearth Furnaces. Illustrates and describes a circulating system installed at South Sharon, Pa. 700 w. Ir Age—April 21, 1910. No. 13279.

A New Reversing Valve for Regenerative Furnaces (Neues Umschalteventil für Regenerativfeuerungen). Illustrated description. 1500 w. Giesserei-Zeit—March 1, 1910. No. 13365 D.

Rolling Mills.

The Flattening Effect of Rolling (Das Breiten beim Walzen). Ernst M. Scheld. A discussion of the laws governing lateral extension in rolled material. Ills. 3300 w. Stahl u Eisen—March 9, 1910. No. 13358 D.

A Graphical Method of Investigating the Speed Ratio in Roll Trains (Ein graphisches Verfahren zur Untersuchung der Geschwindigkeitsverhältnisse von Umkehrstrassen). Oskar Rudbach. Describes a method involving the use of continuous indicator diagrams. Ills. 2500 w. Stahl u Eisen—March 23, 1910. No. 13362 D.

LEAD AND ZINC.

Lead Smelting.

Midvale Blast Furnace Practice. Leroy A. Palmer. Illustrates and describes the arrangement and management of lead furnaces. 2000 w. Mines & Min—April, 1910. No. 12866 C.

Smelting Bismuth-Lead Ore, Sinaloa, Mexico. S. E. Bretherton. Describes the ore and method of treatment. 2000 w. Eng & Min Jour—April 9, 1910. No. 13008.

Silver-Lead Smelting in Tasmania. Theodore Kapp. An account of the smeltery erected by the Tasmanian Smelting Co., near Zeehan. 1500 w. Eng & Min Jour—April 2, 1910. No. 12877.

Tasmania.

Notes on the Zeehan Mining Field, Tasmania. Gerard W. Williams. Describes the tin-silver-lead deposits, mining methods, and metallurgical work. 3000 w. Eng & Min Jour—April 2, 1910. No. 12874.

Zinc Smelting.

Treatment of Complex Zinc Sulphide Ores at Oker. Hermann Pape. An account of what has been accomplished in Germany by the Pape-Witter-Babe smelting process. 2500 w. Eng & Min Jour—April 16, 1910. No. 13128.

Charging and Cleaning Machine for Zinc Furnaces. O. Saeger. Illustrated description. 1200 w. Eng & Min Jour—April 9, 1910. No. 13010.

MINOR MINERALS.

Aluminium.

Production of Aluminium as a Laboratory Experiment. B. Neumann and H. Olsen. Refers to process used in practice, and former experiments, and describes the experiments of the authors. 3500 w. Met & Chem Engng—April, 1910. No. 12799 C.

Asphalt.

The Asphalt Industry in Sicily (L'Industria dell' Asfalto in Sicilia). Angelo Coppadoro. The first part discusses the importance of the industry and the composition of the deposits. Ills. Serial. 1st part. 3000 w. Industria—March 6, 1910. No. 13347 D.

Bismuth.

See Lead Smelting, under LEAD AND ZINC.

Diamonds.

The Arkansas Diamond Fields in 1909. John T. Fuller. Brief review of the incorporated companies and their properties. 800 w. Eng & Min Jour—April 9, 1910. No. 13006.

Graphite.

Origin of Certain Adirondack Graphite Deposits. Edson S. Bastin. Deals principally with their characteristics and the conditions under which they have been formed. Ills. 7000 w. Ec-Geol—March, 1910. No. 13493 D.

The Graphite Deposits in Southern Bohemia, with Special Reference to the Schwarzbach, Stuben and Mugrau Mines (Das Graphitvorkommen im südlichen Böhmen mit besonderer Berücksichtigung der Bergbaue Schwarzbach, Stuben und Mugrau). Josef Breitschopf. Ills. Serial. 1st part. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—March 12, 1910. No. 13368 D.

Marble.

The Wealth of Georgia's Marble Industry. William H. Stone. An illustrated account of the extensive deposits, the uses made of it, the quarries and finishing works, etc. 6000 w. Mfrs' Rec—April 14, 1910. No. 13080.

Oil.

The Commercial Value of the Oil-Shales of Eastern Canada, Based on Their Contents by Analysis in Crude Oil and Ammonium Sulphate. Dr. R. W. Ells. Read before the Min. Soc. of Nova Scotia. 12500 w. Ind Adv—April, 1910. No. 13617.

The Oil Fields of the Gulf of Mexico. John C. Soley. Chart showing the position and extent, with the history, description of deposits, and discussion of their source and genesis. 2500 w. Sci Am Sup—April 9, 1910. No. 12983.

Platinum.

The Russian Platinum Industry in the Year 1909. E. de Hautpick. A review

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of the year, discussing causes of reduced production, prices, etc. 4000 w. Min Jour—March 26, 1910. Serial. 1st part. No. 12929 A.

Quicksilver.

Guadalupe Quicksilver Works. Courtenay De Kalb. Reviews briefly the development of this property in California. Ills. 900 w. Min & Sci Pr—March 26, 1910. No. 12803.

Radioactive Minerals.

The Elements of Radium and Radioactivity. L. F. Miller. Deals with the known radioactive elements and their properties; the minerals, the ores with which they are associated, and how to recognize pitchblende. Ills. 2500 w. Min Wld—April 16, 1910. No. 13143.

Tin.

Franklin Mountain Tin Prospects. Regis Chauvenet. An account of location, extent and geology of these deposits near El Paso, Texas, the nature of the ores and development. 3300 w. Mines & Min—April, 1910. No. 12862 C.

Tin Mining in the Federated Malay States. Brief description of methods of mining and treatment. 1800 w. Aust Min Stand—Feb. 16, 1910. No. 13034 B.

The Erzgebirge Tin Deposits. Joseph T. Singewald, Jr. A summary of literature on these deposits, with observations made by the author on a recent trip to the points where mining is still in progress. 3500 w. Ec-Geol—March, 1910. Serial. 1st part. No. 13495 D.

Tungsten.

Notes on Tungsten Minerals from Montana. Alexander N. Winchell. Describes the character and occurrence of the tungsten minerals which have served as ores in Montana. Ills. 2000 w. Ec-Geol—March, 1910. No. 13494 D.

Structure of the Tungsten Deposits of Moose River, N. S. E. R. Faribault. Read before the Min. Soc. of Nova Scotia. A study of the Tungsten-bearing mineral scheelite and its economic importance. 2200 w. Ind Adv—April, 1910. No. 13616.

MINING.

Assay Plans.

See Records, under MINING.

Boring.

A Deep Boring at Heswell, Cheshire. An account of explorations for concealed coal measures. 3500 w. Ir & Coal Trds Rev—April 8, 1910. No. 13175 A.

See also Prospecting, under MINING.

Bunk Houses.

Housing Conditions at the Garfield Smelter. L. S. Austin. Illustration, and brief account of the arrangements for housing laborers of different nationalities. 1200 w. Min & Sci Pr—April 23, 1910. No. 13584.

Drainage.

Mine Drainage in Joplin District. Lucius L. Wittich. Method by which large amounts of water are handled are illustrated and described. 3200 w. Mines & Min—April, 1910. No. 12864 C.

Electric Haulage.

Description of Electric-Haulage Plant in Operation in No. 5 Colliery, Sydney Mines, Nova Scotia. Robert Robertson. Read before the Min. Soc. of Nova Scotia. 3300 w. Ind Adv—April, 1910. No. 13618.

Electric Hoisting.

Electric Mine Hoists. D. B. Rushmore and K. A. Pauly. A detailed discussion of the advantages of the electric system. 6500 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13229 F.

The Electric Hoist at the Heinitz Mines, Beuthen, Upper Silesia (Die elektrische Fördermaschine der kons. Heinitzgrube in Beuthen, O.-S.). Herr v. Groddeck. Illustrated description. 2500 w. Glückauf—March 12, 1910. No. 13374 D.

Electric Power.

See Switch Gear, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosives.

Underground Magazine at the Hohenthal Mine, Helbra, Germany (Das unterirdische Sprengstofflager des Hohenthalschachtes bei Helbra). Dr. Heinhold. Illustrated description. 1300 w. Glückauf—March 26, 1910. No. 13377 D.

Haulage.

Ore Handling Plants in the Lorraine-Luxemburg Minette District, Especially the Haulage Plant of the Düdelingen Ironworks (Massenförderanlagen im lothringisch-luxemburgischen Minettebebiet, insbesondere die Seilförderungen des Eisenhütten-Aktien-Vereines Düdelingen). Fr. Tillmann. Illustrated description. 5000 w. Zeitschr d Ver Deutscher Ing—March 12, 1910. No. 13511 D.

Hoisting Engines.

See Valve Setting, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Law.

Growth of American and Australian Mining Law. A. C. Veatch. Compares the laws of America and Australia, explaining the causes that helped to form them. 9500 w. Eng & Min Jour—April 2, 1910. No. 12875.

Mine Waters.

See Sterilization, under CIVIL ENGINEERING, WATER SUPPLY.

Prospecting.

Copper Prospecting with Churn Drills in Arizona. William G. Weber. An account of the work. Ills. 3000 w. Wis Engr—April, 1910. No. 13201 D.

Quarrying.

The Ashokan Reservoir Stone Quarry. Describes methods of work at the Yale quarry, where stone is prepared for this great engineering work. 2200 w. Eng Rec—April 2, 1910. No. 12836.

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Records.

Mount-Morgan Mine Records and Assay Plans. J. Bowie Wilson. An explanation of the assay plans and their value, the records, etc. 3000 w. Eng & Min Jour—April 2, 1910. No. 12873.

Shaft Sinking.

Sinking by Means of Underhanging Tubbing. Describes plant and method used at Hamsterley Colliery, England. 1000 w. Eng & Min Jour—April 23, 1910. No. 13417.

Filbert Mine Concrete-Lined Shafts. A. F. Allard and Herbert S. Patterson. Methods and materials used, and machinery employed in sinking and lining this shaft in Fayette County, Pa. Ills. 8500 w. Mines & Min—April, 1910. No. 12868 C.

Stoping.

Method of Square Set Stoping at Bisbee. Morris J. Elsing. Describes this method which is used almost exclusively at Bisbee, Ariz., and gives details of timbering. 2300 w. Eng & Min Jour—April 2, 1910. No. 12872.

Surveying.

Measurements in Leased Properties (Kontrollvermessungen in verliehenen Grubenmassen). Viktor Kadainka. Discusses methods of determining underground boundaries. Ills. Serial. 1st part. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—March 5, 1910. No. 13367 D.

Timbering.

See Stoping, under MINING.

Track Switches.

Novel Automatic Switch. C. S. Beach. Describes a device by which loaded and empty cars are automatically switched alternately. 1500 w. Mines & Min—April, 1910. No. 12869 C.

Valuation.

Examining and Sizing-Up Mine Prospects. Arthur Lakes. Suggestions helpful in forming a correct estimate of prospects. 2500 w. Min Wld—April 23, 1910. No. 13435.

ORE DRESSING AND CONCENTRATION.

Diaphragm Cones.

Diaphragm Cones and Tube Milling. Walter Neal. Brief illustrated description of the apparatus as used in the mills of the Cia. Minera Las Dos Estrellas, and some experiments made with it as a thickener before tube-milling. 1200 w. Min & Sci Pr—April 2, 1910. No. 12968.

Gold Milling.

Tonopah Extension Mill. John G. Kirchen. A brief description of the machinery and arrangement of the plant. 2000 w. Min & Sci Pr—April 9, 1910. No. 13120.

Lead Milling.

Wet Concentration at Midvale, Utah. Leroy Palmer. Describes the concentrator and methods of saving the lead contents of the ore, and also the lead-iron-zinc concentrate. 3500 w. Mines & Min—April, 1910. No. 12859 C.

MISCELLANY.

Analyses.

Sources of Error in Analyses. R. C. Banner. Discusses incorrect calibration of weights and volumetric apparatus. 1500 w. Min & Sci Pr—April 2, 1910. No. 12970.

Australia.

The Queensland Mining Industry. Report of the under-secretary for mines, reviewing the industry for the year 1909. 22500 w. Queens Gov Min Jour—March, 1910. No. 13036 B.

Chemical Industries.

The Chemical Industries of America. Charles E. Munroe. Address at meeting of the Am. Inst. of Chem. Engrs., Phila. Gives a sketch, based on the best statistical data, of the chemical industries of the United States, their present extent and future possibilities. 2500 w. Met & Chem Engng—April, 1910. Serial. 1st part. No. 12802 C.

Congo.

Mining-Conditions in the Belgian Congo (Congo Free State). Sydney H. Ball and Millard K. Shaler. Information concerning conditions, topography, geology, prospecting, mining, and products in this part of Africa. Maps & Ills. 800 w. Bul Am Inst of Min Engrs—April, 1910. No. 13537 F.

Mineralogy.

Determination of Common Ores and Minerals. J. P. Rowe. Gives a few physical tests for determining with some accuracy the more common ores and minerals. 3500 w. Min Wld—April 2, 1910. No. 12880.

Ore Deposits.

Geology Applied to Mining. T. A. Rickard. The Le Neve Foster Memorial Lecture, delivered at the Royal School of Mines, London, on March 4, 1910. Reviews the early history of geological study and the study of ore deposits, and summarizes the conclusions now accepted. 3000 w. Min & Sci Pr—April 2, 1910. Serial. 1st part. No. 12966.

Some Causes of Ore Shoots. R. A. F. Penrose, Jr. Defines the term and considers the influences which act singly or together in producing them. Ills. 10800 w. Ec-Geol—March, 1910. No. 13492 D.

Relation of Mineral and Chemical Industries. George T. Holloway. Abstracted from *Jour. of the Soc. of Chem. Ind.* A study of the formation of typical minerals from their igneous source to the forms familiar to mineralogists. 4000 w. Min Wld—April 9, 1910. Serial. 1st part. No. 13020.

Petrography.

Coloration of Clays by Aniline Coloring Matters (Coloration des Argiles par les Couleurs d'Aniline). M. F. Grandjean. A discussion of the utilization of the ab-

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sorption properties of clays in petrographic researches. 3000 w. Rev de Métal—March, 1910. No. 13317 E + F.

Refractory Materials.

The Thermal Conductivity of Fire Clay at High Temperatures. Gives results of experiments to determine heat losses in furnace walls and similar work. Ills. 2500 w. Ir Trd Rev—April 28, 1910. No. 13576.

Tropical Countries.

Mining in Tropical Climates. John Power Hutchins. Suggestions for overcoming the difficulties and for prevention of sickness. Ills. 5300 w. Mines & Min—April, 1910. No. 12858 C.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signalling.

Railway Signalling. V. I. Smart. Outlines the development of the present system of train operation by Standard Code, comparing with train operation in Europe, and commences a discussion of methods that will give greatest safety, expedition in movement, and lowest possible cost consistent with these. 3500 w. Can Engr—April 22, 1910. Serial. 1st part. No. 13437.

Report on the Question of Operation of Switches and Signals (Subject X for Discussion at the Eighth Session of the Railway Congress). Prof. Dr. Ulbricht. A review of progress in Continental countries. 18500 w. Bul Int Ry Cong—Jan., 1910. No. 13602 G.

Report on the Question of Operation of Switches and Signals (Subject X for Discussion at the Eighth Session of the Railway Congress). E. C. Carter. A review of conditions existing in America. Ills. 4400 w. Bul Int Ry Cong—March, 1910. No. 13484 G.

How to Be a Good Maintainer. William Rife. Considers the essentials of successful maintenance of mechanical interlocking. 2000 w. Sig Engr—April, 1910. No. 13203.

The Chemistry of the Gravity Battery. With special reference to its installation and maintenance in railway signaling. 2000 w. Sig Engr—April, 1910. No. 13202.

Train Acceleration.

An Instrument for Measuring Acceleration and Gradient. Ilustrated description of the Wimperis accelerometer, explaining its applications. 800 w. Eng News—April 28, 1910. No. 13573.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

I. Triple Valve Test Rack. II. Triple Valve Tests. Illustrates and describes this test rack, and remarks on triple valve tests. 1500 w. Ry & Loc Engng—April, 1910. No. 12795 C.

Baggage Cars.

Cars for Handling Baggage Trucks, Hudson Tunnel Lines. Illustrated description of an all-steel car for transporting loaded trucks to eliminate extra handling. 1000 w. Ry & Engng Rev—April 9, 1910. No. 13031.

Car Disinfection.

The Disinfecting of Passenger Coaches. P. Schumacher. From *Ann. fur Gewerbe und Bauwesen.* Illustrated description of the apparatus, its operation, and results. 2500 w. Ry Age Gaz—April 1, 1910. No. 12889.

Car Ventilation.

Ventilation of Cars. Brief illustrated description of the method devised by T. H. Garland. 700 w. Ry & Loc Engng—April, 1910. No. 12791 C.

Electrification.

Report of Committee on Electrification. Report and general discussion, with illustrations. 22000 w. Pro N Y R R Club—March 18, 1910. No. 13197.

Electrification of the Bavarian State Railways. J. Jacquin. A review of a recent report. 8600 w. Bul Int Ry Cong—Jan., 1910. No. 13605 G.

Electric Traction on the Mersey, the Midland, and the North Eastern Railway. Papers by Shaw, Dalziel & Sayers, and Harrison discussed together. Ills. 60000 w. Inst of Civ Engrs—Nov. 9, 1909. Papers 3794, 3847 and 3863. No. 13271 N.

Freight Cars.

Steel in Freight Car Construction. C. A. Seley. An illustrated article describing an improved design of structural steel freight cars, where the value of the superstructure as a truss has been considered as an element of strength. 2500 w. Jour Fr Inst—April, 1910. No. 13534 D.

Steel Car Construction. C. R. Harris. Read before the New England Ry. Club. Discusses the relative merits of structural steel and pressed steel, favoring the former. Ills. 6000 w. Ry Mas Mech—April, 1910. No. 13066.

See also Locomotive Designs, under MOTIVE POWER AND EQUIPMENT.

Lighting Cars.

A Motor Lighting Car (Voiture automobile d'Eclairage). G. Zindel. Describes a European car equipped with generating machinery to supply light for night work, tunnel examinations, etc. Ills. 1800 w. Bul Tech d l Suisse Romande—March 25, 1910. No. 13328 D.

We supply copies of these articles. See page 479.

Locomotive Boilers.

Report on the Question of Improvements in Locomotive Boilers (Subject VI, Littera A and B, for Discussion at the Eighth Session of the Railway Congress). H. H. Vaughan. Considers boilers with smoke tubes, and boilers with water tubes, superheaters, and feed water heaters in America. Ills. 26500 w. Bul Int Ry Cong—Feb., 1910. No. 13608 G.

On the Question of Improvements in Locomotive Boilers (Subject VI, Littera B, for Discussion at the Eighth Session of the Railway Congress). Franz Gerstner. Report for Austria-Hungary, Rumania, Bulgaria, Servia and Turkey on boilers with water tubes, steam superheaters and valve gear for superheated steam and feed-water heaters. Ills. 9800 w. Bul Int Ry Cong—March, 1910. No. 13479 G.

Improvements in Locomotive Boilers in Belgium, Spain, France, Italy and Portugal (Perfectionnements des Chaudières de Locomotives en Belgique, Espagne, France, Italie et Portugal). M. Nadal. A general review. 12000 w. All Indus—March, 1910. No. 13329.

Locomotive Construction.

Economy of Removable Driving Box Brasses. W. J. Shadle. Drawings and explanation of successful devices. 1000 w. Am Mach—Vol. 33. No. 17. No. 13554.

Report on the Question of the Use of Steel (Subject V, Littera A, for Discussion at the Eighth Session of the Railway Congress). D. F. Crawford. The use of steel in the construction of rolling stock in America is discussed. Ills. 15500 w. Bul Int Ry Cong—Feb., 1910. No. 13607 G.

The Use of Steel in Locomotive and Car Construction. Extracts from a report by D. F. Crawford for discussion at the International Railway Congress. Aims to give results obtained in America from a general operating and maintenance standpoint. 4500 w. Ry Age Gaz—April 1, 1910. No. 12888.

See also Alloy Steels, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

Locomotive Fuels.

Wheeling & Lake Erie Coal Tests. A report of tests made to determine economy of different grades. 2000 w. Ry Age Gaz—April 22, 1910. No. 13410.

Fuel Tests on the Wheeling & Lake Erie R. R. A digest of a report of these tests made by B. A. Worthington; and instructions for fuel tests by J. E. Muhlfeld. 2500 w. Ry & Engng Rev—April 9, 1910. No. 13030.

Locomotive Literature.

The Books of the Locomotive. Lawford H. Fry. A review of important books on the locomotive, covering English, French, German and American practice. 3500 w. Engr, Lond—March 25, 1910. Serial. 1st part. No. 12940 A.

Locomotive Operation.

Coal and the Locomotive. George S. Hodgins. Aims to trace the action of the stored power in coal until it produces motion in the modern locomotive. 2500 w. Ap Sci—March, 1910. No. 13213 C.

Locomotive Power.

Tractive Power Analyzed. George S. Hodgins. Diagrams and analysis. 1200 w. Ry & Loc Engng—April, 1910. No. 12788 C.

Locomotives.

Report on the Question of Steam Locomotives for Very High Speed (Subject VII for Discussion at the Eighth Session of the Railway Congress). William Garstang. Considers steam locomotives for obtaining regulation speeds exceeding 60 miles per hour in America. Ills. 7700 w. Bul Int Ry Cong—Feb., 1910. No. 13609 G.

Tank Engines for Fast Passenger Traffic. Illustrates and describes the principal features of recent designs, and gives information concerning the work done by them on British railways. Plate. 1200 w. Engr, Lond—April 1, 1910. No. 13060 A.

The First Application of the Mallet System to High-Speed Locomotives (La première Application du Système Mallet aux Locomotives à grande Vitesse). Henry Martin. Describes and discusses the new Santa Fe locomotive. Ills. 2500 w. Génie Civil—March 12, 1910. No. 13336 D.

The Mallet Compound Locomotive and Its Limitations. Editorial discussing its present unfitness for fast service. 700 w. Ry Age Gaz—April 22, 1910. No. 13405.

Mallet Pusher Locomotive: Canadian Pacific Railway. Describes the special features of an engine built for operation on heavy grades and used as a pusher. 1500 w. Eng News—April 7, 1910. No. 13002.

An Experimental Mallet Articulated Locomotive. Illustrated detailed description of an engine designed and constructed for the Canadian Pacific Ry., calling attention to its novel features. 3000 w. Mech Engr—March 25, 1910. No. 12930 A.

Mallet Articulated for the B. & A. Illustration and description of a new engine for hauling freight on steep grades. 1200 w. Ry & Loc Engng—April, 1910. No. 12793 C.

Mallet Articulated Compound Locomotive, 2-6-6-2 Type. Illustrated description of a locomotive with large boiler capacity built for freight service on the Boston & Albany R. R. 1000 w. Am Engr & R R Jour—April, 1910. No. 13024 C.

Mallet Locomotives for the Southern Pacific. Illustrated description. 500 w. Ry Age Gaz—April 22, 1910. No. 13408.

Mallet Articulated Compound Locomotive. New York Central Lines. Illustrated description of a new locomotive for the Boston & Albany division. 1200 w. Ry Age Gaz—April 1, 1910. No. 12887.

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New Locomotives for the St. Louis & San Francisco R. R. Co. Illustrates and describes the Pacific type for passenger service, and the consolidation type for heavy freight service. 1200 w. Ry & Engng Rev—April 16, 1910. No. 13146.

Baldwin Mallet for the Galveston, Harrisburg & San Antonio Ry. Illustration with description of recently built engines. 800 w. Ry & Loc Engng—April, 1910. No. 12789 C.

Eight-Coupled Locomotives; Natal Government Railways. Illustrations, with description of 14-wheeled locomotives for 3 ft. 6 in. gauge. 700 w. Engng—April 1, 1910. No. 13056 A.

Six-Coupled Locomotive for the Tientsin-Pukow Railway, China. Illustrated description of an American-built engine. 400 w. Engng—April 15, 1910. No. 13463 A.

Motor Cars.

Report on the Question of Motor Vehicles (Subject XII for Discussion at the Eighth Session of the Railway Congress). L. Greppi. The use and cost of motor vehicles or self-moving cars, in all countries except Great Britain and America. Ills. 19000 w. Bul Int Ry Cong—March, 1910. No. 13483 G.

Inspection and Repair of Motor Cars. W. B. Kouwenhoven. Describes the methods of inspection to determine repairs needed. 2000 w. Ry & Loc Engng—April, 1910. No. 12796 C.

Passenger Cars.

New Private Car for the Queen of England. C. Van Langendonck. Illustrated detailed description. 1000 w. Ry Age Gaz—April 15, 1910. No. 13125.

See also Locomotive Design, under MOTIVE POWER AND EQUIPMENT.

Shops.

Readville Locomotive Shop—New York, New Haven and Hartford Railroad. Illustrated description of the arrangement and construction of the buildings, grouping and location of the machine tools and methods of operation of the shops. 4500 w. Am Engr & R R Jour—April, 1910. No. 13023 C.

Car Wheel Foundry and Practice, Chicago, Milwaukee & St. Paul Railway. George L. Fowler. Illustrated detailed description of the foundry, the manufacturing methods and tests. 5000 w. Ry Age Gaz—April 1, 1910. No. 12890.

Locomotive and Car Shops of the Isthmian Canal Commission. Extract from the annual report of the Isthmian Canal Commission giving data on the motive power department of the Panama R. R. Ills. 2500 w. Ry Mas Mech—April, 1910. No. 13065.

Convenient Pickling Vat. Illustrated description of a new arrangement in the equipment of the St. Louis & San Francisco R. R. shops at Springfield, Mo. 900 w. Ry & Loc Engng—April, 1910. No. 12790 C.

Sleeping Cars.

New Steel Pullman Sleeping Car. Illustrated description. 500 w. Ry Age Gaz—April 29, 1910. No. 13597.

New Sleeping Cars for the Illinois Traction System. Illustrated detailed description of sleeping cars for an interurban road. 2000 w. Ry & Engng Rev—April 23, 1910. No. 13436.

Train Ferries.

See Ferry Steamers, under MARINE AND NAVAL ENGINEERING.

Train Lighting.

Electric Car Lighting. J. R. Sloan. Presents the advantages of electric lighting, the systems that have been followed and the difficulties of each. General discussion. 8000 w. Pro Cent Ry Club—March 11, 1910. No. 13532 C.

NEW PROJECTS.

Arabia.

The Hedschas Railway (Die mohammedanische Eisenbahn, Hedschasbahn). E. A. Ziffer. A brief general description of the project. Ills. 5000 w. Zeitschr d Oest Ing u Arch Ver—March 4, 1910. No. 13397 D.

Switzerland.

New Swiss Railway Projects (Neue schweizerische Eisenbahnprojekte). R. Moser. A brief review of proposed lines. Ills. 3000 w. Schweiz Bau—March 26, 1910. No. 13381 B.

Trinidad.

Railway Extensions in Trinidad. Information concerning proposed extensions of great importance to the island. 700 w. Ry Age Gaz—April 1, 1910. No. 12885.

PERMANENT WAY AND BUILDINGS.

Construction.

Rocklin-Colfax Second Track Construction, Southern Pacific Co. Illustrated description of construction work through a broken country, requiring 17 tunnels of various lengths in about 36 miles. 1500 w. Ry & Engng Rev—April 2, 1910. No. 12907.

Elevated Railways.

Track Elevation on the Chicago, Milwaukee & St. Paul at Evanston, Ill. Illustrated description of work of interest because of artistic design and the methods of handling traffic while the work was in progress. 2000 w. Ry Age Gaz—April 8, 1910. No. 12976.

Stations.

Report on the Question of Large Stations (Subject IX for Discussion at the Eighth Session of the Railway Congress). Mr. Julien and Mr. Leverve. Considers best arrangement of tracks, improved appliances, etc., for all countries except America, Russia, Austria-Hungary, Rumania, Bulgaria, Servia and Turkey. Ills. 7000 w. Bul Int Ry Cong—Feb., 1910. No. 13614 G.

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Switches.

See Track Construction, under PERMANENT WAY AND BUILDINGS.

Terminals.

Grand Central Improvement Work. Illustration and information relating to the new station of the N. Y. C. & H. R. R. R. 700 w. Ry & Loc Engng—April, 1910. No. 12792 C.

New Locomotive Terminal of the Vandalia at Terre Haute, Ind. Illustrates and describes the general arrangement and details of the principal structures. 1200 w. Ry Age Gaz—April 22, 1910. No. 13409.

Ties.

The Supply and Employment of Beech Railway Ties (Die Beschaffung und Verwendung buchener Eisenbahnschwellen). Herr Schneidt. Discusses the use of beech railway ties in Germany. Ills. 11000 w. Glasers Ann—March 1, 1910. No. 13394 D.

Track Construction.

Report on the Question of Junctions and Swing-Bridges. Elimination of Slacking (Subject III for Discussion at the Eighth Session of the Railway Congress). F. Tettelin and M. Cossmann. Considers arrangements of the road appliances for passing at high speed over switches and swing-bridges in France, Italy, Spain and Portugal. Ills. 10900 w. Bul Int Ry Cong—Feb., 1910. No. 13611 G.

Report on the Question of Junctions and Swing-Bridges. Elimination of Slacking (Subject III for Discussion at the Eighth Session of the Railway Congress). L. Motte. Considers the arrangement of road appliances for passing at high speed over switches and swing bridges, in all countries except France, Italy, Spain, Portugal, Great Britain and America. Ills. 8000 w. Bul Int Ry Cong—March, 1910. No. 13482 G.

On the Question of Junctions and Swing-Bridges. Elimination of Slacking (Subject III for Discussion at the Eighth Session of the Railway Congress). W. G. Besler. Report for America in regard to arrangement of road appliances for passing at high speed over switches and swing bridges. Ills. 5000 w. Bul Int Ry Cong—March, 1910. No. 13478 G.

Track Maintenance.

Railway Maintenance of Way. W. H. Hoyt. Suggestions for the maintenance of a first class roadbed. Ills. 3500 w. Minn Engr—March, 1910. No. 13075 C.

Tunnels.

Report on the Question of Long Railway Tunnels. Construction, Ventilation and Operation (Subject IV for Discussion at the Eighth Session of the Railway Congress). Mr. Canat. Considers tunnels in mountainous countries (the Alps excepted) and great town tunnels (Great Britain excepted). Ills. 30000 w. Bul Int Ry Cong—Feb., 1910. No. 13613 G.

Report on the Question of Long Railway Tunnels. Construction, Ventilation and Operation (Subject IV for Discussion at the Eighth Session of the Railway Congress). Felix Sartiaux. Considers methods used for submarine tunnels. Ills. 7300 w. Bul Int Ry Cong—Feb., 1910. No. 13610 G.

Report on the Question of Long Railway Tunnels. Construction, Ventilation and Operation (Subject IV for Discussion at the Eighth Session of the Railway Congress). F. Hennings. Illustrated description of the Alpine tunnels. 15200 w. Bul Int Ry Cong—Feb., 1910. No. 13615 G.

Yards.

Freight Yard Construction. Claude L. Van Auken. A general account of the work, with special reference to a yard near Chicago. 2800 w. Wis Engr—April, 1910. No. 13199 D.

The Long Island Improvements of the Pennsylvania System. Map and illustrated description of the Sunnyside yard on Long Island, with editorial note. 4000 w. Eng Rec—April 16, 1910. No. 13138.

Western Pacific Yards and Terminals. Gustave E. Lemmerich. Illustrates and describes interesting details. 1500 w. Ry Age Gaz—April 22, 1910. No. 13407.

The New Wustermark Shunting Yard. Description. 1500 w. Bul Int Ry Cong—Jan., 1910. No. 13606 G.

TRAFFIC.

Car Interchange.

Note on the Utility of Studying the Question of Freight Car Interchange and Demurrage. W. F. Allen. A discussion of car service problems. 80000 w. Bul Int Ry Cong—Jan., 1910. No. 13600 G.

Freight.

Report on the Question of Transhipment (Subject XX for Discussion at the Eighth Session of the Railway Congress). C. de Burlet. Examination of the different systems adopted for the exchange of goods between lines of different gauges. Ills. 9000 w. Bul Int Ry Cong—Jan., 1910. No. 13604 G.

The Transit Privilege: Abuses of It and Some Proposed Remedies. S. O. Dunn. Explains the uses of the transit privilege, its misuses, and suggests plans for improving present conditions. 5000 w. Ry Age Gaz—April 29, 1910. No. 13596.

A Remarkable Record in Low Cost Freight Haulage on a Railway of Heavy Traffic. Editorial on the operating records of the Bessemer & L. Erie R. R., its heavy traffic and the low cost of handling freight. 1200 w. Eng News—April 21, 1910. No. 13262.

Freight Rates.

What Is the Rate Making Power of the Interstate Commerce Commission? A critical discussion of the authority of the commission. 2000 w. Ry Age Gaz—April 29, 1910. No. 13595.

Which Line Makes the Rate? William

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Z. Ripley. An examination of this question, with the conclusion that everything depends on local circumstances and conditions. 2500 w. Ry Age Gaz—April 1, 1910. No. 12884.

Pullman Rates.

Pullman Car Changes Found unreasonable. Reprint of the decision of the Interstate Commerce Commission in the Pullman case with editorial discussion. 2500 w. Ry Age Gaz—April 15, 1910. No. 13124.

Waterway Competition.

Report on the Question of Railways and Waterways (Subject XIII for Discussion at the Eighth Session of the Railway Congress). William E. Hoyt. An investigation of the influence of waterways considered as feeders and as competitors, in America. 3900 w. Bul Int Ry Cong—Feb., 1910. No. 13612 G.

Report on the Question of Railways and Waterways (Subject XIII for Discussion at the Eighth Session of the Railway Congress). C. Colson and Louis Marlio. Investigates the influence of waterways considered as feeders and as competitors of railways in all countries except Great Britain and America. Ills. 4600 w. Bul Int Ry Cong—March, 1910. No. 13481 G.

MISCELLANY.

Accounting.

Railway Depreciation Accounts. C. J. Sturgis. Address before the Nat. Assn. of Ry. Com. Considers depreciation accounts in relation to the question of railway regulation. 4000 w. Ry Age Gaz—April 8, 1910. No. 12975.

See also Statistics, under MISCELLANY.

Belgium.

The Light Railways of Belgium. Lionel Wiener. Illustrates and describes local transportation developments. 2500 w. Cassier's Mag—April, 1910. No. 13194 B.

England.

The Enfield and Stevenage New Loop Line. Map and description of a new line for the Great Northern (England), 5 miles in length. Bridges and viaducts are illustrated. 1700 w. Engr, Lond—April 1, 1910. No. 13061 A.

Madagascar.

The Brickaville-Tananarive Railway (Note sur le Chemin de Fer de Brickaville à Tananarive). M. R. Godfernaux. Describes the construction of this railway in Madagascar. Ills. 13000 w. Rev Gen d Chemins de Fer—March, 1910. No. 13322 G.

Management.

The Fundamental Principles of Efficiency. Harrington Emerson. A discussion of efficiency in railroad operation. General discussion. 17500 w. Pro Ry Club of Pittsburgh—Feb. 25, 1910. No. 13196 C.

Natal.

The Natal Government Railways and the Policy of Improvement. Editorial discussion of conditions in South Africa and the problems that affect the railways. 2500 w. Engng—April 15, 1910. No. 13464 A.

Statistics.

Report on the Question of Statistics (Subject XIV for Discussion at the Eighth Session of the Railway Congress). W. M. Acworth. Considers principles of statistics of railways in operation, and the uniform classification of working expenses. 4000 w. Bul Int Ry Cong—Jan., 1910. No. 13599 G.

United States.

The Railways' Cost of Living. Frederick E. Voegelin. Reviews the accounts for 1907, comparing with 1897, as reported by the Interstate Commerce Commission. 2500 w. Ry Age Gaz—April 15, 1910. No. 13123.

STREET AND ELECTRIC RAILWAYS.

Brakes.

Electric Braking on Glasgow Corporation Tramcars. A. Gerrard. Abstract of a paper read before the Inst. of Elec. Engrs. Information concerning the Newell brake of old and recent types, reporting tests. Also refers to an automatic sanding apparatus. 5500 w. Elec Engr, Lond—April 8, 1910. No. 13152 A.

Canal Haulage.

Gantry-Frame Two-Side Towing Locomotive for Lock Haulage, Bremen, Germany. Illustration, with brief description, of the "electric mule" for boat haulage at locks of Weser River dam, Bremen, Germany. 400 w. Eng News—April 21, 1910. No. 13261.

Car Barns.

Construction of New Buildings, Improvement of Existing Structures, Fire Protection and Insurance—Metropolitan Street Railway. Illustrated description of recent improvements in New York City. 5500 w. Elec Ry Jour—April 16, 1910. No. 13118.

Car Inspection.

Inspection of Car Equipment on Electric Railways. M. B. Lambert. Gives an outline of a system of value in maintaining cars so that there will be few interruptions of service. 2500 w. Elec Jour—April, 1910. No. 13211.

Inspection and Repair of Electrical Equipment. Describes electrical practices

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of a company whose methods are thorough and give satisfactory results. Ills. 1600 w. Elec Ry Jour—April 2, 1910. No. 12822.

Car Maintenance.

See Shops, under STREET AND ELECTRIC RAILWAYS.

Cars.

Value of Lightness in Cars. M. V. Ayres. Considers the saving in operating expenses and the results of reducing the weights of cars. 2000 w. Elec Ry Jour—April 16, 1910. No. 13119.

Storage Battery and Gasoline-Electric Cars on the Third Avenue Railroad. Illustrates and describes the new storage-battery cars on trial, and gives data on the operation of the storage-battery, and gasoline-electric cars. 1200 w. Elec Ry Jour—April 23, 1910. No. 13297.

Reduced Weight Semi-Convertible Car. Illustrated description of an interesting design built for the Boston & Northern and the Old Colony street railways. 3500 w. Elec Ry Jour—April 2, 1910. No. 12821.

Car Ventilation.

Types of Street Car Ventilating Systems. The Cooke system, and the Peter Smith car ventilator are illustrated and described. 1200 w. Heat & Vent Mag—April, 1910. No. 13544.

Electric Traction.

Electric Traction on the Continent. A. J. Thompson. Illustrates and describes special installations on main line railways in Switzerland, Germany, and other parts of the Continent. 5000 w. Cassier's Mag—April, 1910. No. 13191 B.

Report on the Question of Electric Traction (Subject VIII for Discussion of the Eighth Session of the Railway Congress). George Gibbs. Deals with electric traction on large railroads in America, discussing continuous and alternating current and the comparative cost. Ills. 13500 w. Bul Int Ry Cong—Jan., 1910. No. 13601 G.

On the Question of Electric Traction (Subject VIII for Discussion at the Eighth Session of the Railway Congress). Dr. Gleichman. A discussion of electric traction on large railroads in Germany, continuous and alternating current and the comparative cost. Ills. 17400 w. Bul Int Ry Cong—March, 1910. No. 13480 G.

Interurban.

The 1200-Volt Railroad—A Study of Its Value for Interurban Railways. Charles E. Eveleth. Compares the 1200-volt and 600-volt direct-current systems in the interurban field, claiming economical advantages for the former. General discussion. 5000 w. Pro Am Inst of Elec Engrs—April, 1910. No. 13237 F.

Locomotives.

Centre of Gravity and Oscillations in Electric Locomotives (Schwerpunktlage und Kreiselwirkungen bei elektrischen Lokomotiven). G. Brecht. A discussion of the influence of the position of the centre of gravity. Ills. Serial. 1st part. 4500 w. Elek Kraft u Bahnen—March 4, 1910. No. 13506 D.

Electric Locomotive for the N. Y., N. H. & H. Railroad. Illustrates and describes an engine designed primarily for handling fast freight, but will also be used for fast passenger service. 1200 w. Ry & Loc Engng—April, 1910. No. 12794 C.

Lyons, France.

The Street Railway System of the City of Lyons, France. Alfred Gradenwitz. Illustrated description of a line recently converted to the single-phase system. 1500 w. Elec Rev, N Y—April 30, 1910. No. 13619.

Monorail.

The Technical and Economic Possibilities of Monorailways (Die technischen und wirtschaftlichen Aussichten der einschienigen Kreiselbahn). Herr Schimpff. A discussion of their engineering features. 4000 w. Elek Kraft u Bahnen—March 4, 1910. No. 13507 D.

The Brennan and Scherl Monorail Cars (Automotrices Monorails à Gyroscopes Systèmes Brennan et Scherl). Ch. Dantin. A description and comparison of the systems. Ills. 2500 w. Génie Civil—March 26, 1910. No. 13341 D.

Motor Maintenance.

Recent Practice in Motor Maintenance in Boston. Illustrates and describes special appliances of a labor-saving character. 3000 w. Elec Ry Jour—April 9, 1910. No. 12973.

Municipal Ownership.

The Financial Position of Tramway Undertakings, Owned and Worked by Municipal Corporations, as Indicated by the Tramway and Light Railways Return of the Board of Trade for 1908-1909. 4500 w. Tram & Ry Wld—March 10, 1910. No. 12721 B.

Operating Costs.

Cost of Operating the Manhattan Elevated Railways. Gives itemized costs of operating the Manhattan Elevated in New York City for the year ending June 30, 1908. 1200 w. Engng-Con—April 20, 1910. No. 13404.

Cost of Constructing and Operating the Electric Street Railways of Long Island City—The New York and Queens County Railway. Gives data relating to the year ending June 30, 1908. 1500 w. Engng-Con—April 27, 1910. No. 13557.

Rack Railways.

The Salève Electric Rack Railway (Notice sur le Chemin de Fer électrique à Crémaillère du Salève). M. Vagneux. Brief description of an installation near Geneva. 2000 w. Ann d Ponts et Chaussées—1910-I. No. 13311 E + F.

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Shops.

Interesting Shop Practices at Indianapolis. Describes methods of caring for wheels, brakes and motors on a large road. Ills. 3500 w. Elec Ry Jour—April 2, 1910. No. 12824.

Shops of the Cincinnati Traction Company. Illustrates and describes the motor-driven tools, the armature shop methods, and the system of card records used. 4500 w. Elec Ry Jour—April 2, 1910. No. 12823.

Shops of the London Underground Electric Railways. Illustrates and describes interesting features of the tube shops. 1500 w. Elec Ry Jour—May 7, 1910. No. 13766.

Department of Rolling Stock and Shops of the Metropolitan Street Railway, New York. An illustrated account of important improvements made in this department since the appointment of receivers. 6000 w. Elec Ry Jour—April 2, 1910. No. 12820 C.

Improvements in the Department of Rolling Stock and Shops of the Metropolitan Street Railway. Describes detailed improvements in methods and machinery. Ills. 2500 w. Elec Ry Jour—April 9, 1910. No. 12974.

The Interborough Repair Shops. W. B. Kouwenhoven. Explains methods of inspection and repair in uses at these shops. 2000 w. Ry & Loc Engng—May, 1910. No. 13640 C.

Signals.

Automatic Signals for Electric Railways. Carl P. Nachod. A brief illustrated review of electric railway signalling with a description of a particular type of contact system. 3000 w. Jour Fr Inst—April, 1910. No. 13535 D.

Snow Removal.

Snow Fighting Methods and Organization of the Metropolitan Street Railway Co. An explanation of the organization and methods in force in New York City. 3000 w. Elec Ry Jour—April 23, 1910. No. 13296.

Subways.

Cost of the New York Subway and of Operating It. Considers the first cost, cost of equipment, and cost of operation. 2000 w. Engng-Con—April 13, 1910. No. 13091.

Traffic Conditions Influencing Passenger Subway Construction in Chicago, Ill. Outlines traffic conditions, and the plans that have been proposed for constructing subways. Diagrams. 1500 w. Engng-Con—April 20, 1910. Serial. 1st part. No. 13403.

Maintenance and Operating Features of the Electrified St. Clair Tunnel. An illustrated account of the performance of this line. 7500 w. Elec Ry Jour—April 2, 1910. No. 12825.

Electric Traction Development. An account of the Sydney harbor subway scheme, with map. 3500 w. Aust Min Stand—March 16, 1910. No. 13488 B.

Subway Ventilation.

The Ventilation of the New York and Paris Subways (Ventilation des Métropolitains de New York et de Paris). H. Deniau. A review and comparison of the two methods of subway ventilation. Ills. Serial. 1st part. 1800 w. Rev Indus—March 19, 1910. No. 13332 D.

Switzerland.

The History of the Seebach Wettingen Railway. W. J. Finke. Brief history of an experimental electric line which gave successful operation, but for financial reasons went back to the use of steam. 2500 w. Minn Engr—March, 1910. No. 13078 C.

Terminals.

The Two-Story Street Railway Terminal of the Public Service Railway, Hoboken, N. J. John M. Barney. Plans, sections, illustrations and description of a large terminal building under construction. 1000 w. Eng News—April 21, 1910. No. 13265.

Track Construction.

City Track Construction. W. A. Heindle. Read before the Iowa St. & Int. Ry. Assn. The types and methods described refer to recent work in the cities of Davenport, Rock Island, and Moline. 2000 w. Elec Ry Jour—April 23, 1910. No. 13299.

City Track Construction for Electric Interurban Railways. H. L. Weber. Abstract of a paper read before the Central Elec. Ry. Assn. Gives plans for satisfactory track construction in city streets. 1500 w. Eng News—April 14, 1910. No. 13104.

Track Maintenance.

Tramway Track Maintenance and Renewal. Henry Mattinson. Deals with the causes of deterioration, particularly in regard to damage by water, and the way it may be prevented. Ills. 4000 w. Surveyor—April 15, 1910. No. 13449 A.

Department of Maintenance of Way and Buildings—Metropolitan Street Railway Company. Illustrated account of the organization and work of this department. 4000 w. Elec Ry Jour—May 7, 1910. No. 13767.

Vienna.

Projects for Improving Traffic Facilities in Vienna (Vorschläge zur Verbesserung der Wiener Verkehrsverhältnisse). Karl Hochenegg. Describes present conditions and discusses possible improvements. Ills. 6500 w. Zeitschr d Oest Ing u Arch Ver—March 25, 1910. No. 13399 D.

We supply copies of these articles. See page 479.

EXPLANATORY NOTE—THE ENGINEERING INDEX

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingeniería. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.